FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 101
No. 2076
Registered at the G.P.O. as a Newspaper

JULY 26, 1956
Offices: John Adam House, John Adam St., London, W.C.2

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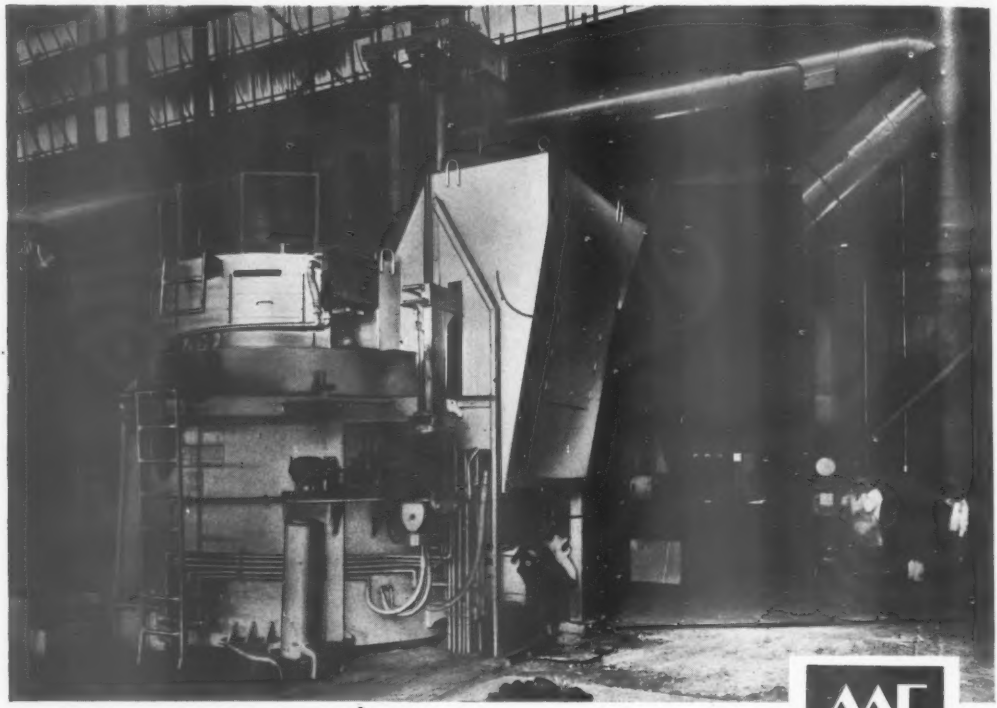

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FOUNDRY TRADE JOURNAL

Established 1902

Vol. 101 Thursday, July 26, 1956 No. 2076

Editor:
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AN INDUSTRIAL NEWSPAPERS PUBLICATION

Published Weekly

Single copy 9d.; by post 1s.
Annual subscription: home 40s., abroad 45s. (prepaid).

17/19 JOHN ADAM STREET, ADELPHI, LONDON, W.C.2

'Phone: TRAfalgar 6171 (10 lines)
'Grams: Zacatecas, Rand. London.

Iron and Steel Foundries Regulations—Progress Report

A very interesting meeting was held in Wolverhampton last week, organized by the National and Midland Ironfounders' Association, which body was until then the Midland Ironfounders' Association. It was addressed by Sir George Barnett, Her Majesty's Chief Inspector of Factories. This was followed by a "Brains Trust" which allowed the posing and answering of questions germane to the requirements of the newer Regulations for the conduct of iron and steel foundries. It was pleasing to hear Sir George express his satisfaction at the great progress that had been made in the compliance with these Regulations. Rightly, he stressed the great importance that should be attached to the stipulations which are actually the cheapest to carry out—in fact, we should place them in the category of making a contribution to profits—namely, those to be associated with good housekeeping.

Sir George expressed himself as being quite satisfied that the research done on the control of dust arising from grinding machines when dealing with castings and the devices developed to this end are of such a character that they are ready for adoption by industry. Long experience of statements such as this by Chief Factory Inspectors gives us reason to believe that it will not be long before legislation will be enacted requiring all foundry grinding machines to carry the new gadgets for added dust removal. Sir George mentioned that but few foundries had asked for exemption from the provision of baths and changing facilities, yet we wonder if it is generally known that some foundries have decided to cease manufacturing as, owing to their small capacity, their output was unable economically to sustain these added non-productive costs. It is a pity that modern legislation does not differentiate between factories and workshops, for in truth, the smaller jobbing shops enter into this category. Moreover, the tempo of production in the latter is such that danger from industrial diseases is quite remote and the accident rate is, we believe, quite low.

Some of the matters arising from the discussion were of distinct interest. For instance, an excellent definition of a pouring gangway was given—as the pathway leading from the source of metal to the casting station, but no further. Its extension beyond this position could, with certain methods of manufacture commonly practised, lead to a 50 per cent. reduction in floor space and, consequently, production. The traditional method of straddling moulds is thought to be a safer method of pouring than by side action. A desire was expressed that the interpretations of the new Regulations by the district inspectors should be unified, as they appear at the moment to be bordering on the chaotic.

G

IBF National Works Visits

Detailed Arrangements for October 12

In view of the outstanding success of the six previous annual national works visits days, the Institute of British Foundrymen has decided to repeat the experiment this year, and has accepted the offer of the Lancashire branch to make the arrangements. These works visits supplement the arrangements which are already made by branches and those afforded at the annual conference, and in particular enable those members who cannot spare the time to attend the whole of the annual conference to take part in an annual national gathering. In the present instance, the Institute is indebted to the Lancashire branch and especially to its secretary, Mr. F. W. Nield, for undertaking this work. The arrangements made are as follow:—

Programme

Visits will take place on Friday, October 12, when a large number of important founders in the Manchester area have kindly agreed to receive parties of members. The firms have been divided into groups of two, and each group of visits will consist of one in the morning and one in the afternoon, as shown below. Luncheon will be provided at some suitable place about mid-day. Members are asked to indicate on a reply form which group of visits they wish to attend and as the number permitted to attend each group is strictly limited, their second and third choices. Coaches leave from Lower Mosley Street bus station (near the Central Railway Station) for visits "A," "B," "C," and "D" at 9.15 a.m., and for visit "E" at 8.45 a.m.

In the evening there will be a dinner and entertainment at the Midland Hotel, Manchester. The charge for each group of visits including transport by coach, luncheon, gratuities, and administrative expenses is 21s., and the additional charge for dinner in the evening at the Midland Hotel is 21s. Members who desire to participate are requested to return the reply form to the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3, not later than Saturday, September 8, or earlier if possible.

In order to provide accommodation for visitors from other branches, the Lancashire branch has agreed to limit the number of its own members in each group. Bookings from all other members will be allocated strictly in the order in which they are received. Members participating are required to make their own arrangements for hotel accommodation, and are advised to book at the earliest possible moment (and in any case not later than September 8).

IBF Cardiff Conference Fund

In addition to the subscriptions to the conference fund of the Institute of British Foundrymen, published in the April 12 and June 7 issues of the FOUNDRY TRADE JOURNAL, the following donations have been received:—

	£	s.	d.
Previously acknowledged	2,055	10	0
Foundry Trades' Equipment and Supplies Association*	221	0	0
H. Taylor	9	2	0
Mrs. E. Rawden	1	1	0
F. S. Ashafa Motajo	1	1	0
	£2,287	14	0

* This donation was contributed by members of the Association as follow:

Alldays & Onions, Limited; August's, Limited; British Moulding Machine Company, Limited; Carborundum Company, Limited; Fordath Engineering Company, Limited; Foundry Services, Limited; Incandescent Heat Company, Limited; A. Lakin & Son, Limited; Marco Conveyor & Engineering Company, Limited; Pneulec, Limited; Sternol, Limited; Isaac & Israel Walker, Limited; William Aske & Company, Limited; British Foundry Units, Limited; British Ronceray, Limited; Constructional Engineering Company, Limited; Foundry Plant & Machinery, Limited; General Refractories, Limited; J. W. Jackman & Company, Limited; E. S. Lord, Limited; Midland Heating & Ventilation Company, Limited; Sterling Foundry Specialties, Limited, and E. Tallis & Sons, Limited.

Appointments to ESC Subsidiaries

New appointments to the boards of its wholly owned subsidiary companies are announced by the English Steel Corporation, Limited, Sheffield. They include that of Mr. G. Craven, a director of the English Steel Export Corporation, Limited, who has been made a director of the English Steel Forge & Engineering Corporation, Limited, responsible for commercial matters.

Mr. C. Muirhead, a director of the English Steel Castings Corporation, Limited, the English Steel Spring Corporation, Limited, and a special director of the English Steel Corporation, and Mr. E. W. Greaves, London representative for railway materials, have been appointed directors of Davis & Lloyd (1955), Limited, designers of railway rolling-stock equipment, etc.

Mr. ERNEST A. TIMSON, managing director of Timsons, Limited, boot and printing machinery makers and ironfounders, of Kettering (Northants), has been elected chairman of the Association of British Manufacturers of Printing Machinery in succession to Mr. JOHN O. CRABTREE, managing director of Hoe & Crabtree, Limited, Leeds.

Programme of Works to be Visited in the Manchester Area (by kind invitation of Directors and Managers of each Company).

Party.	Morning Visit.	Luncheon.	Afternoon Visit.
A	Ferranti, Limited (light electrical and engineering castings; mechanized iron foundry)	Ferranti, Limited	Mather & Platt, Limited (light, medium and heavy engineering castings; iron foundry)
B	Metropolitan-Vickers Electrical Company, Limited (electrical engineering castings; ferrous and non-ferrous foundry)	Metropolitan-Vickers	British Railways, Horwich Works (highly-mechanized iron foundry; railway chairs and brake-block castings)
C	David Brown-Jackson, Limited (light and heavy engineering castings; steel foundry)	(To be arranged)	Lancashire Steel Corporation, Limited (steelworks and foundry)
D	L. Gardner & Sons, Limited (oil-engine manufacturers; iron and non-ferrous foundry)	Joseph Berry, Limited	Joseph Berry, Limited (heavy and light iron castings for smithy and forge plants; forging department)
E	British Insulated Callender's Cables, Limited (iron and non-ferrous foundry; highly mechanized plant producing copper ingots)	British Insulated Callender's Cables, Limited	Manganese Bronze & Brass Company, Limited (non-ferrous foundry; marine propellers, general castings and bronze and brass ingots)

Cupola Experiments*

By K. G. Harris, B.Sc., A.I.M.

Mr. Kenneth G. Harris was appointed to his present position of works metallurgist to the Dowlais works of Guest, Keen Iron & Steel Company, Limited, Cardiff, in 1953, where he is engaged on cupola development. He was educated at Cathays High School, Cardiff, and University College of South Wales and Monmouthshire, where he gained an honours degree in metallurgy. During the late war he served in the Royal Navy (electrical department), and on demobilization in 1946, rejoined his present company. He is an active member of sub-committee T.8.47 of the Institute of British Foundrymen.

The object of this work was to develop a technique whereby the cupola plant at the foundry with which the Author is associated, could supply, economically and metallurgically, the varied needs of the foundry and to investigate the possibilities of five-day-a-week operation under controlled conditions. The variables examined included combustion conditions, optimum charge weights, charge distribution, lining erosion, behaviour of refractories as lining materials, and water cooling. The experiments led to a considerable saving in melting cost per ton of metal produced, together with metallurgical improvements such as, hotter, cleaner metal and increased melting-rate, together with reduced and consistent lining-erosion. A data sheet was developed, enabling the cupola operator to cope with any reasonable changes in materials or conditions. The use of carbon and 70 per cent. alumina bricks as cupola-lining materials showed considerable promise from a metallurgical standpoint, but this was offset somewhat by oxidation difficulties with the carbon lining, and economic considerations with the high-alumina bricks. A simple type of water cooling of the cupola gave interesting and promising results, and this technique applied together with carbon, or 70 per cent. Al_2O_3, lining, should go a long way towards making five-day-week operation possible.

Introduction

This Paper is a record to date of experimental work on cupola plant at the foundry with which the Author is associated. The underlying scheme was to determine optimum and economic working conditions as dictated by the requirements of the foundry, the ultimate aim being five-day-a-week cupola operation under controlled and recorded conditions, which the operator would merely have to follow. The Ivor works of the firm is essentially an ingot-mould foundry, requiring hematite iron of a low sulphur- and phosphorus-content and low silicon- and manganese losses. There is, however, a considerable proportion of jobbing engineering castings made, and the requirements of the foundry are such that a routine casting schedule cannot be planned. The cupola then has to:—(*a*) Supply the right iron at the correct time; (*b*) maintain a constant temperature and melting rate; (*c*) suffer minimum silicon- and manganese-losses, and (*d*) function economically, and to a given set of rules, so that any fluctuations in materials or conditions (providing they are not too severe), can be catered for and coped with by the cupola operator. This programme was, therefore, planned to include combustion conditions, optimum charge-weight, charge distribution, erosion, behaviour of refractories used as lining materials and water cooling.

The cupola plant is shown in Fig. 1; it consists of a new cupola with the dimensions and specification shown in Table I.

TABLE I.—*Dimensions and Specification of the Cupola Plant used.*

Overall height (not including spark arrestor and supports)—40 ft.
Shell—6 ft. 4 in. dia.
Working lining—48-in. dia.
Distance from tuyeres to charging sill—19 ft.
Charging door—5½ ft. by 3½ ft.
Tuyeres—Eight parallel, rectangular of welded steel-plate, ratio of area of furnace cross section at tuyeres to total tuyere area, approximately 3 : 1.
Charging—30-cwt. hand-charged electrically-operated skip hoist, tipping into cupola through charging door.
Air supply—50-h.p. fan blower with air/weight controller fitted.

CUPOLA OPERATION

A series of observations on the cupola operation showed that the metal emerging from it was not uniform in quantity, temperature, or composition, and that the lining erosion was uneven, being more pronounced diametrically opposite to the taphole, above the tuyeres on the charging-door side. These results were attributed to lack of control and knowledge of the coke bed, and consequently, it was decided to perform some trials on the burning of coke with a view to finding out how the composition of the gases formed in the coke bed varied with the height of the bed above the tuyeres. It

*Presented at the annual conference of the Institute of British Foundrymen in Cardiff last month.

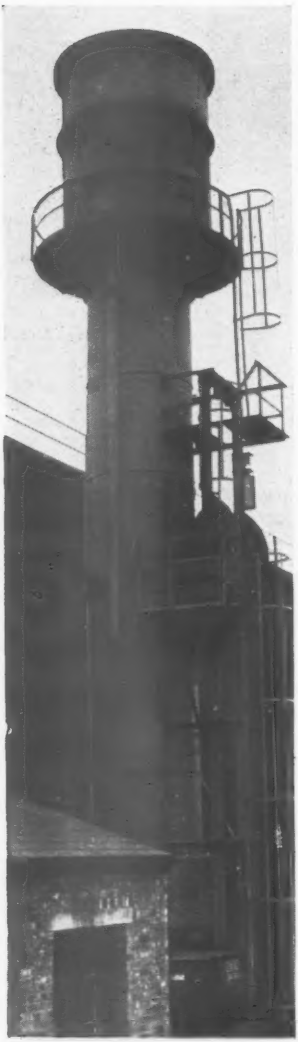


FIG. 1.—*Cupola plant used in the experiments.*

was felt that knowledge of this variation would help to indicate the optimum height of the coke bed, and show the extent of oxidizing conditions within the cupola. The effect of coke size was also observed.

Initial Trials

The method used consisted in kindling a bed of graded coke which extended to approximately four feet above the tuyeres, and then blowing this down as far as possible. Gas samples were taken at frequent intervals and analysed for CO_2, CO, and O_2, and the bed height was determined as each sample was taken, by a simple pulley-and-weight device. The blast volume was kept at a fixed value for all tests, and the whole procedure was repeated for different coke-gradings.

Results, including gas-composition variation with time, bed-heights, and coke grading were plotted graphically, and although somewhat crude (due to lack of sensitive control), the general form of the curves did agree with accepted theories of combustion. The information gained from these, and subsequent tests, suggested that bed-heights of the order of 42-in. above the tuyeres, and coke sizes of 4 to 8-in. were the most likely to yield promising results in the trials and the investigation to determine the position of the melting zone and oxidation information.

Coke Bed and Charge Distribution

The cupola shaft was then lined consistently to a diameter of 48 in., and the coke bed was charged by volume, using a calculated amount of coke to give a consistent and definite bed-height. Observations were taken over a number of melting runs, and these established the following facts:—(*a*) Metal temperature became more consistent, and quality improved (*i.e.*) less oxidized or "burnt" iron was produced, but there was still a tendency for the metal temperature to fluctuate towards the middle and the end of the run. (*b*) Erosion of the cupola lining was still uneven. (*c*) The first metal to appear at the tuyeres did so at the same side of the cupola shaft as the location of the area of most severe lining erosion.

These observations indicated an uneven coke-bed, lower under the charging door than above the taphole. Examination of the skip method of charging the cupola, revealed that the unevenness was inherent in that method. No cure was possible with the existing layout, so a means of minimizing the trouble had to be sought. Consequently, comprehensive observations were taken on the way the charges distributed themselves in the cupola shaft.

The metal charges used normally comprise pig-iron and returned ingot-moulds broken up as scrap; the latter consist of lumps of considerable size and bulk as compared with the pig-iron, coke and lime used in the charge. The angles of the rest of these materials when discharged into the cupola shaft are also very different. Originally, the order of placing these materials into the charging skip was:—(1) Metal (pig-iron and ingot-mould pieces), (2) limestone, and (3) coke.

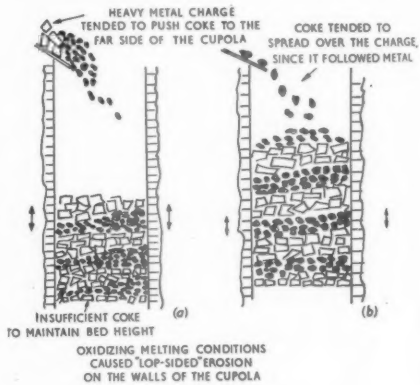

HEAVY METAL CHARGE TENDED TO PUSH COKE TO THE FAR SIDE OF THE CUPOLA
COKE TENDED TO SPREAD OVER THE CHARGE, SINCE IT FOLLOWED METAL
INSUFFICIENT COKE TO MAINTAIN BED HEIGHT
(a)
(b)
OXIDIZING MELTING CONDITIONS CAUSED "LOP-SIDED" EROSION ON THE WALLS OF THE CUPOLA

FIG. 2.—*Charge distribution in the cupola shaft according to order of placing constituents in the skip. Charging order:* (*a*), (1) *metal,* (2) *limestone,* (3) *coke* (*oxidizing melting conditions caused lop-sided erosion on the walls of the cupola*); (*b*), (1) *coke,* (2) *limestone and* (3) *metal.*

The manner in which the charge materials distributed themselves in the cupola shaft is shown in Fig. 2 (a) where it may be seen that the bulky metallic portion of the charge tended to push the

coke to the far side of the cupola, with a consequent coke-depletion and metal build-up on the sill side. This resulted in insufficient coke to maintain the bed height at that position, with the effects previously recorded, *i.e.* uneven lining erosion and oxidizing melting conditions.

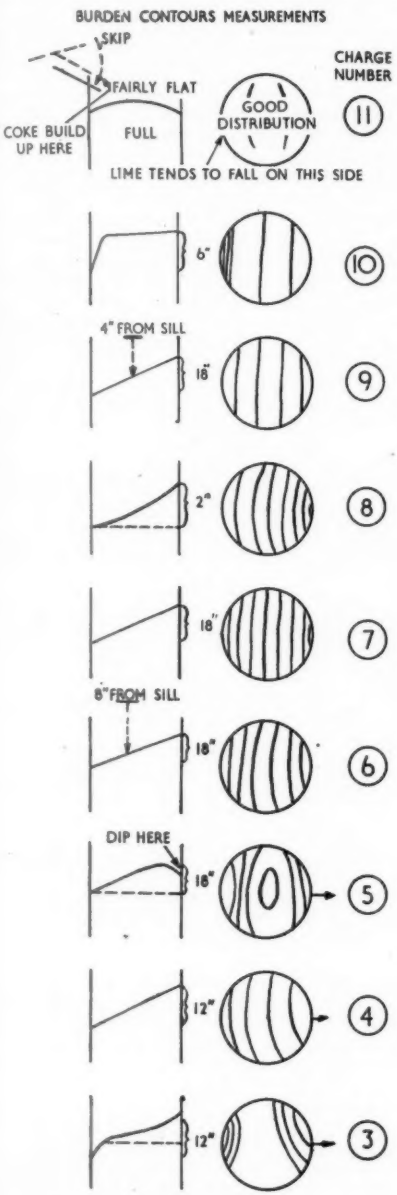


FIG. 3.—*Burden gradients and contours at different positions in the cupola shaft resulting from the charging order*: (1) *coke*, (2) *limestone and* (3) *metal.* (*See also Fig.* 2 (*b*).)

A series of detailed observations of a considerable number of runs in which the manner the charge materials positioned themselves in the shaft, resulted in the adoption of the following procedure:—

(*a*) The well of the cupola was filled with coke up to the tuyeres, and then a simple baffle-plate placed in the shaft at the charging sill ensured a level bed when the final coke was added.

(*b*) The order of placing the materials in the charging skip was altered to: (1) coke, (2) limestone (evenly placed in the coke in the centre of skip), and (3) metal (ingot-mould pieces and pig-iron).

In the first charge after the shaft was full, the order was reversed, for reasons explained later.

The distribution gradient of the charges in the cupola shaft can be followed from the set of contour measurements shown in Fig. 3, although the first two charges were too low in the bottom of the shaft for them to be examined successfully. From the third to the eleventh charges, the contour change revealed the maximum stock-line slope at approximately the eighth charge (about five feet from the charging sill) and at the position where the materials tipped from the skip usually strike the lining. From the eighth to the eleventh charge, the gradient decreased, becoming zero at the tenth charge. The eleventh charge was so close to the lip of the skip as it tipped that the coke did not distribute itself, but merely piled up under the lip. The first charge after the cupola shaft was full was reversed *i.e.* (1) metal, (2) lime, (3) coke, in order to counteract this coke build-up tendency and restore the stock contour approximately to level.

The manner in which the charge materials distributed themselves in the shaft is shown in Fig. 2(b), where it may be seen that the effects shown in Fig. 2(a) had been largely eliminated, and a level bed, reduced erosion and more-regular contour resulted.

Optimum Charge Weights

The next stage consisted in determining optimum charge-weights in order to produce efficient melting rates and temperatures. Of the charge variables, *i.e.* air, metal and coke, it was decided to keep air constant, because of the ease of control conferred by the automatic air/weight controller. It thus became a problem of determining the corresponding weights of metal and coke required for a fixed air volume. This was accomplished in a series of trials in which the coke and metal weights were varied for fixed air-volume inputs, the following observations being taken: (*a*) Metal temperature, (*b*) frequency of tapping, (*c*) melting rate, (*d*) position and amount of lining erosion at the end of the day, and (*e*) analysis of slag and metal samples.

The levelness of the coke bed, the blowing rate and metal:coke ratio were reflected in the uniformity of the metal temperature, *e.g.* an excessively-high metal temperature and low melting-rate indicated insufficient coke in the charge, with consequent burning away of the bed, whilst a low metal-

temperature indicated a too-generous coke-fraction in the charge. Fluctuating temperatures were studied, and remedied by adding extra maintaining-coke at fixed intervals during the "run" to maintain the level of the bed and ensure consistently-hot metal at the taphole. These observations enabled a technique to be developed in which optimum air : metal : coke ratios were established. The technique was then extended to determine conditions for different sizes of coke, including 2 in. by 4 in. cobbles, 4 in. to 6 in. and 6 in. to 12 in.

The small coke was of uniform size, approximately 3 in. cube, and required a much lower bed-height, higher air-input, lower metal : coke ratio and more coke in the charge to produce cupola-operation characteristics similar to those of the larger cokes.

Standard Conditions

The standardized conditions which were developed yielded practically uniform metal, and constant cupola erosion values, and enabled the furnace's behaviour to be predicted with some accuracy. Data sheets were then prepared for the operator which laid down the various procedures required for standard operation and for different types and sizes of coke. A quite considerable saving on melting costs per ton of metal was effected, together with metallurgical improvements such as: (*a*) Hotter, cleaner metal, (*b*) increased melting-rate, (*c*) reduced slag-volume, (*d*) consistent and reduced lining-erosion, and (*e*) generally, more-efficient operation.

Reference to Figs. 4 (*a*) and (*b*) show that starting from a cupola-lining erosion average of 11 to 13 cub. ft. (sometimes "burned" back to the shell); a temperature fluctuation of 50 deg. C. and metal : coke ratio of 7 : 1, it was possible using the new system to reduce these values respectively to 3.5 to 5.0 cub. ft., a temperature range of 10 deg. C. and a metal : coke ratio of 9.5 : 1. As a point of interest, the effect of deliberately sloping the coke-bed from the charging side to the taphole side (*i.e.* the reverse of that obtaining before the experiments were started) was to shift the zone of maximum erosion to the taphole side, as shown in Fig. 4 (*c*).

Charge Distribution

Although, as previously mentioned, the major proportion of the foundry production comprises ingot moulds requiring a hematite iron with low-phosphorus and -sulphur contents, considerable quantities of jobbing engineering castings are also produced. The latter have higher phosphorus and sulphur contents and are produced from charges containing a proportion of engineering-iron scrap having high phosphorus-content. It is not always possible to segregate the manufacture of the different types of castings in the foundry, and in order to overcome mixing of the charges when melting two types of iron consecutively in the cupola, with subsequent contamination, the problem of charge distribution and mixing in the cupola shaft has been investigated. The apparatus used consisted of an old metal furnace-stack about 11½-ft. long by 2½-ft. dia., mounted on end to serve as a cupola. It was filled to two thirds of its height with coke, and then charged from the top with predetermined alternate layers of pig-iron and coke painted in different colours for identification purposes. The charges were tipped in as they would be in the actual cupola setup and then raked out from the bottom, and the amount of mixing assessed. To find the effect of heavier charges of metal, the metal layers were double and treble banked.

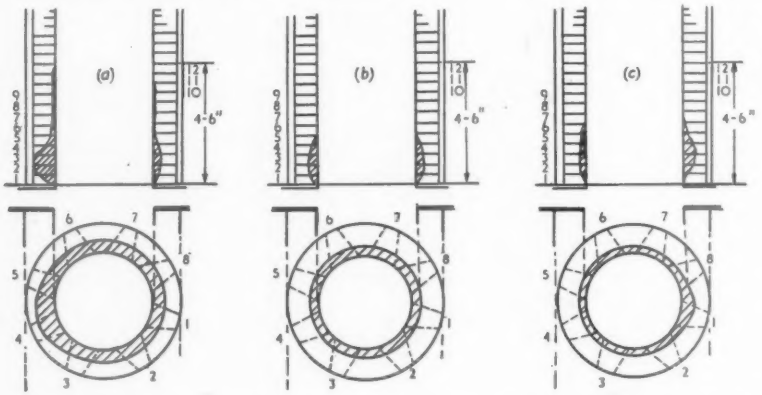


FIG. 4.—*Plan and elevation of cupola-lining erosion resulting from* (*a*) *conditions prior to experiments,* (*b*) *standard operational methods developed and* (*c*) *deliberate coke build-up on the side opposite to the charging door* (*charging door left, and taphole right in all illustrations*).

The results included the following:—

(*a*) The charge coke mixed both intimately and quickly; observations from the top as the "charge" was sinking revealed that the coke "trickled" around the sides of the "cupola"; as the heavier metal layer prepared to drop, the metal tended to "hang" for a second or so. The coke thus mixed with the succeeding layer and so on.

(*b*) Contamination varied inversely with the thickness of the metal layers, *i.e.*, deep layers preserved their identities better than shallow ones, *i.e.*, considering three numbered pig-iron layers, No. 1 mixed with No. 2, No. 2 mixed with No. 3, and No. 1 did not generally mix with No. 3.

(*c*) A tunnelling effect occurred around the sides of the "cupola" whilst the centre section of the charge moved slowly down the axis of the "furnace" shaft. This could explain an "off-composition" tap from a cupola, particularly if a hang-up occurred at the centre section for a very short period.

(*d*) The generally applied method in cupola practice of allowing an extra charge above and another below special metal charges so as to make sure of obtaining the special metal required, appeared to be borne out.

It was necessary next to augment the information on physical mixing with some on chemical mixing and this was accomplished by taking and analysing metal samples from each tap of the cupola throughout a particular day for Si, P and Mn. Charge metal composition to metal tapped correlations were carried out and graphs were drawn. Fig. 5 shows the type of curve obtained for P, being the element with which the Author is most concerned. This graph was prepared from data obtained from a 5-ft. dia. cupola, but approximates closely to the results also obtained from the cupola plant used in the tests described.

When charges containing a high percentage of engineering-iron scrap (having high-phosphorus content) are added to a cupola engaged on melting low-phosphorus material, contamination of the lower charges by phosphorus occurs quickly, the value in the example shown increasing from 0.095 per cent. to as much as 0.22 per cent. over two charges, *i.e.*, four tons of metal. To ensure the required amount of low-phosphorus iron, at least two extra "buffer" charges from which engineering-iron scrap has been excluded must be added before charging the high-phosphorus iron. This information enabled the Author to evolve a system of charging which has minimized phosphorus and sulphur contamination of the lower charges in the cupola shaft from charges higher in the cupola shaft. The work has now resulted in metal being obtained economically from the cupola of correct composition and metallurgical properties to suit the foundry's needs.

REFRACTORIES

Carbon

Investigations followed on the behaviour of different refractories, from a metallurgical and economic viewpoint, when used as cupola linings. Carbon was the first choice, and in view of the complete absence of any published information of this material as a cupola-lining refractory, information could only be obtained by conducting a trial, with the ideas in mind that if carbon could be used to line the cupola, the following advantages relative to present practice would result. (1) Five-days-a-week availability of the cupola (2) considerably-reduced maintenance costs (3) cupola metal available for the foundry, 1½ to 2 hours earlier in the day, and (4) lower slag-volumes, better slag-control and lower oxidation-losses.

To achieve these improvements, the carbon lining would have to withstand oxidation by the air blast for quite long periods, and it was felt that by paying particular attention to the coke bed, its maintenance, and the blowing rate of the cupola, the chances of a carbon lining having a good life was sufficient to justify the cost of a trial.

Diagrammatic details of the cupola-lining construction are shown in Fig. 6 and briefly, the following method was adopted for the two zones —the cupola well up to the tuyeres and the shaft up to 4 ft. 6 in. above the tuyeres.

Below the Tuyeres

The well was formed from a layer of 9- by 4½- by 3-in. insulating bricks on end shown at (A) in Fig. 6 and fronted with carbon bricks 9- by 6/5½ by 3-in. shown at (B) in Fig. 6 the latter being keyed by blocks cut from 9- by 6- by 3-in. carbon bricks. There were nine courses of brick up to within 1½ in. of the steel tuyere-boxes, the gap being rammed with a proprietary refractory patching material shown dotted in Fig. 6. These nine courses were

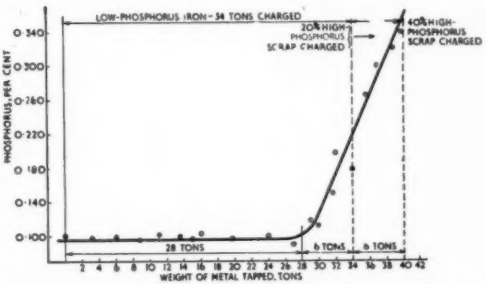


FIG. 5.—*Cupola operational record showing the contamination produced in a normal iron, low in phosphorus, as a result of adding supplementary charges high in phosphorus.*

backed with insulating bricks (Fig. 6) to ensure that metal in the well was kept hot, because the high thermal-conductivity of carbon would otherwise permit a rapid loss of heat.

Above the Tuyeres

A ½-in. layer of the refractory ramming material was first applied to cover the rivet heads in the shell, and then the lining was formed from 12-in. carbon bricks ((C) in Fig. 6) keyed to give correct curvature. There were sixteen courses of these, the remainder of the shaft being bricked with ordinary firebricks.

Both the slag notch and the taphole were preformed, the slag notch out of four firebricks and the slaghole out of the proprietary refractory rammed around a former. The carbon lining was given a protective wash of bentonite cream to minimize oxidation whilst drying with a fire, and a wall of firebrick covering the carbon lining and tuyere apertures was built. The cupola was boxed up and dried for 48 hrs. by a coke fire placed in the well. The protective bricking was then removed by dropping the doors, and the cupola bottom was then made up from well-milled Dorset yellow sand, care being taken to ensure that the slope of the

bottom would allow all the iron and slag to drain away after the day's run.

Operation with a Carbon Lining

The cupola was charged and worked as normal, with the exception that the limestone addition was reduced, there being no SiO_2 or Al_2O_3 pick-up from the lining; it was intended to make a less-acid slag than normal. The cupola was actually run for two days without dropping the bottom, and delivered metal at a constant temperature, but with a lower melting-rate than normal (about 5½ tons per hour). After the first day, the blast was turned off, the slag drained away, and the coke bed made up to compensate for burning losses overnight. A "hard hole" developed the second day, and although metal temperature and melting rate were similar to the previous day's run, difficulties occurred which culminated in the shell above the slag notch getting red hot and the redness spreading around the tuyere level, together with seepage of hot metal from under the launder. The run was then abandoned, the air was turned off and the lining cooled to dull red by water sprays, before dropping the bottom.

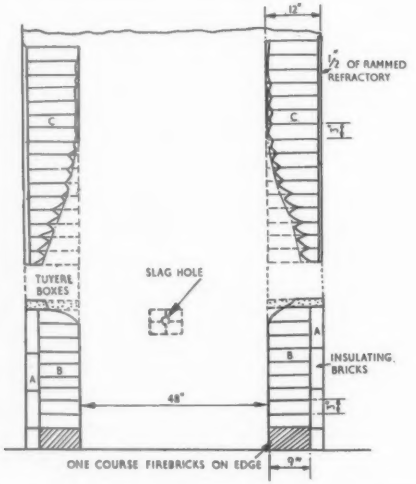


FIG. 6.—*Profile of the cupola shaft, as freshly lined with carbon bricks and after two days' operation.*

Examination of the lining when cool revealed considerable damage. Large areas of erosion had occurred above and below the tuyere-boxes, which were severely oxidized and scaled themselves. The lines of the carbon brickwork are shown in Fig. 6. Below and above the tuyere-boxes, the carbon bricks had been oxidized away, the air appearing to have attacked the joints preferentially, leaving the tapered ends of the remaining bricks projecting. This effect is shown by the dotted lines in Fig. 6. The slag notch was completely destroyed, but the rammed taphole block was apparently free from attack.

Typical slag and metal compositions (per cent) were as follow:—

	SiO_2	Al_2O_3	CaO	Mn	Fe
Slag:					
(A)	35.2	17.2	38.5	3.2	3.1
(B)	38.1	15.5	36.9	3.6	4.0
Metal:					
	Si	S	P	Mn	
	1.07	0.065	0.100	0.75	

Conclusions

(1) The evidence indicated that air and CO_2 had caused the severe damage to the carbon lining by seeping between the red-hot lining and the column of charge, hence oxidizing the bricks away. The damage was probably initiated during the night, when the cupola was shut down. The hot air rising from the burning bed, and the draught created by the 19 ft. shaft caused air to be sucked in from various leaks, particularly at the tuyere doors. This air had seeped into the joints of the hot brickwork creating gaps; then, later, with the blast on, the air passing between the lining and the charge "swilled" over this network of gaps, and hence, erosion progressed rapidly on the second day, with the results noted.

(2) The metallurgical results obtained with the carbon lining were very favourable, and supported the investigators' expectations in this respect. Normal cupola slags contain approximately 44 SiO_2, 20 CaO and 18 to 20 Al_2O_3 per cent. respectively, these being the main constituents. Slags of these compositions are acid and viscous, and because of these features, carry up to 5 per cent. metallic iron as shot, and have a high affinity for the basic oxides, FeO and MnO the percentage (FeO and MnO) running from 13 to 15 per cent.

The slags produced with the carbon lining were much more basic, with increased fluidity. No metallic iron was detected and the total (FeO and MnO) was approximately half that of the normal slag. An important result of this difference in slag composition was reflected in the sulphur content of the metal, *viz*: 0.064 per cent. Normally this figure is between 0.09 and 0.10 per cent.

(3) It was felt that a rammed monolithic-lining would be more successful than one of carbon-brick. If the lining was well and carefully dried to minimize crack-formation, erosion such as that encountered, should not occur. The cupola would have to be well "boxed-up" with no leaks when the bed was burning overnight.

A successful and well maintained carbon lining would, on the observations of this trial be a great asset from both metallurgical and economic viewpoints, and the possibilities of carbon used in conjunction with the type of water-cooling outlined later in this Paper will be considered eventually.

HIGH-ALUMINA BRICK LINING

It was decided to investigate the behaviour of a high-alumina brick lining in the melting of one of the cupolas, from the point of view of lower maintenance costs and slag volume, *etc.*, consequently, a panel of 70 per cent. alumina bricks 26 by 34 in. was built into the cupola above the tuyeres, and the amount of wear and erosion

under normal working conditions was compared with that of normal firebrick under similar conditions of service. The results obtained were encouraging, and in consequence it was felt that a lining of such bricks would last at least six days without requiring patching.

A complete lining of 70 per cent. alumina brick was installed in the melting zone, details of installation were as follow: The cupola was bricked above the tuyeres with 12 courses of 70 per cent. alumina-brick "keys" of dimensions 9 by 4½/3.37 by 3 in. The jointing material was a high-alumina cement, and any cracks or spaces around the tuyere-boxes, *etc.*, were rammed with a proprietary high-alumina patching-compound. The tuyere-boxes were cut to the circumference of the cupola lining, permitting a flush fit. The well was constructed of normal firebrick. The lining was dried slowly over a period of two days, and the bed was put in on the third day, when the lining was finished off and dried.

The cupola was worked normally as per data

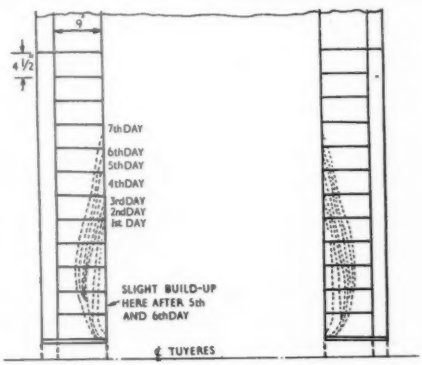


FIG. 7.—*Progress of erosion during seven-days' operation of a cupola lined in the melting zone with 70-per-cent. alumina bricks.*

sheet, and the following observations were made: (1) Temperature of the metal trapped (2) slag, volume and weight (3) number of times slagging was carried out, and (4) position and amount of erosion after each day's run. A slag sample was taken from each flush and was analysed for total Fe, SiO_2, Al_2O_3, CaO, Mn, and S.

The cupola was run for seven days and melted approximately 180 tons of iron without any patching of the lining. The progress of the lining erosion day-by-day is shown in Fig. 7, and was not too extensive, being confined to six courses above the tuyeres and most severe at the third and fourth courses. After the seventh day, the lining was patched with 70 per cent alumina brick and subsequently, completed ten days melting—a total of over 275 tons of iron. Examination of the data collected during the ten days' investigation showed the following points:—(*a*) The erosion of brick-work per ton of iron produced averaged 15.5 lb. Reference to Fig. 8 shows that this is considerably below the average for normal firebrick, the latter being of the order of 40 lb. per ton. (*b*) Tapping temperatures were remarkably constant. (*c*) The weight of slag produced per ton of iron was, on an average, 0.65 cwt. Fig. 8 indicates that this is well below the average of the results for firebrick lining practice, *i.e.* 1.2 cwt. per ton of metal melted. Further, the actual weight of slag produced with

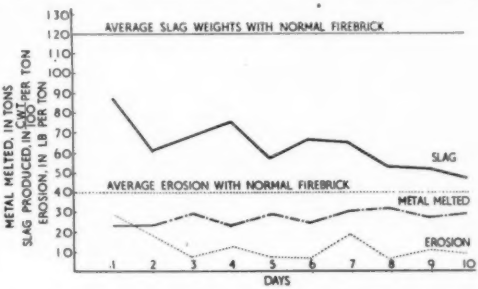


FIG. 8.—*Slag/erosion/tonnage figures for an experimental cupola lining of 70-per-cent. Al_2O_3 brick.*

the 70 per cent alumina lining was approximately 13 to 15 cwt. per day, as compared with 35 to 40 cwt. with good practice when using a firebrick lining. Another point of note was that with this lining slagging was only required on an average, twice a day, whereas with firebrick, four times daily is quite normal.

(*d*) The composition of the slag samples taken was examined and Table II shows a comparison with those produced when a firebrick lining was used. The main items of interest arising from consideration of the slags are that: (1) The Al_2O_3 content is, on the average, 50 per cent. higher than for a firebrick slag. This, of course, is to be expected since the bricks contained 70 per cent. Al_2O_3 as compared with approximately 35 per cent. for the usual bricks used; (2) The SiO_2 content of the slag is generally lower—33.0 per cent. as against 37 to 42.0 per cent. for firebrick. This again can be expected owing to the lower SiO_2 content of the bricks. (3)

TABLE II.—*Comparison of Slag Compositions obtained from Cupola Linings of 70 per cent. Al_2O_3 Bricks and Normal Firebrick.*

	Slag composition (per cent.)	
	70 per cent. Al_2O_3 bricks.	Firebrick.
SiO_2	Approx. 33.0	37.0—42.0
Al_2O_3	25.0—30.0	Approx. 17.0
CaO	29.0—35.0	29.0—35.9
Mn	2.5—4.5	3.0—3.4
CaO/SiO_2	0.8—1.2	0.7—0.9

The CaO content is approximately the same for both firebrick and 70 per cent. alumina, *i.e.* 29.0 to 35.0 per cent. (see Table II) However, owing to the considerable decrease in slag volume carried, it was possible to reduce the limestone addition to

the cupola charge by over 35 per cent. and still preserve a good fluid slag. (4) A correlation is apparent between the CaO, and S contents of the slags, and Fig. 9 (*a*) shows that this relationship is practically linear over the range of values obtained. A plot of sulphur in the slag against the $CaO:SiO_2$ ratio over the values obtained is shown in Fig. 9 (*b*). This tends to take the form of a gentle curve and suggests that for low values of the $CaO:SiO_2$ ratio, little or no desulphurization occurs, whilst for higher values, the efficiency of S removal is reduced. This is borne out by observation since for normal firebrick practice the values of the $CaO:SiO_2$ ratio are much lower, and generally little or no sulphur is found in the slag analysis.

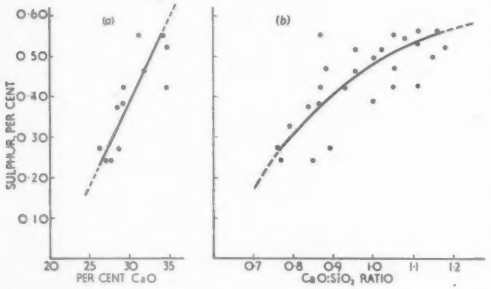


FIG. 9.—*Variations of sulphur content of slag*: (*a*) *with CaO content and* (*b*) *with* $CaO:SiO_2$ *ratio.*

Economic Considerations

Over the ten-day period of the trial, the maintenance costs of cupola operation were very low, being a fifth of the cost when using a normal firebrick lining over the same period. However, the initial cost of relining with 70 per cent. alumina bricks, was six times that of relining with firebick, this almost entirely due to the high cost of the alumina bricks. Hence, over the trial period a fairly high cost per ton of iron produced was incurred.

To reveal the long-term effects of adopting this special cupola lining the ten-day period figures were computed to see what the cost would be for a 12-month period with certain additions to standard bricking procedure, based on the observed erosion, and position of the lining in the melting zone. This computation gave a somewhat lower cost per ton, but it did not take into account inevitable wear and replacement of brickwork higher up in the melting zone, nor did it allow for "unprecendented" occurrences.

The conclusions to be drawn from the experiment with the high-alumina brick lining are:—Metallurgically there are several advantages (*a*) a considerable reduction in maintenance (*b*) a low slag-weight and reduced slag-volume, with a consequent saving in limestone and hence, more heat efficiency from the charge coke, (*c*) reduced slagging periods, and (*d*) a desulphurizing slag. Economically, the high cost of the brick as compared with firebrick outweigh the metallurgical benefits. However, it is felt that used in conjunction with the system of water cooling to be described later, more-economical operation should result.

WATER COOLING

The results and experience gained from the use of carbon and high-alumina brick linings, suggested that if some simple method of water cooling could be incorporated into the lining at the actual erosion zone, decided metallurgical, economic and maintenance advantages should accrue, particularly if the cooling could be used in conjunction with the 70 per cent. Al_2O_3 or carbon bricks. It was felt that (*a*) a preliminary trial should be carried out to indicate the trends and pitfalls ; (*b*) an extended and more-complete installation could be made, based on the results of (*a*), but using firebrick to indicate quickly the effect of several cooling-pipes upon each other and the neighbouring brickwork ; (*c*) incorporating the set-up evolved from the results of (*b*) into, first, a 70 per cent. Al_2O_3 brick lining, and then a rammed carbon-lining.

For the preliminary trial, a water-cooled ring consisting of a pipe 1-in. i.d. of solid-drawn, hydraulically-tested steel was embedded in the normal firebrick lining of the cupola approximately 10 in. above the tuyeres in the zone of maximum erosion, and 1 in. from the working surface. It was then rammed and covered with ganister (Fig. 10). A water flow of approximately 12 galls. per min. was used, running from the time the fire was lighted to the time the cupola was cool enough

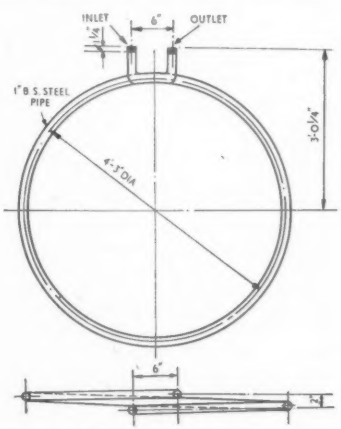


FIG. 10.—*Water-cooling ring incorporated into a cupola lining* 10 *in. above the tuyeres.*

for the mason to enter for patching. A daily record of the pipe's effect on the lining was kept. The pipe survived 12 days' operation during which nearly 400 tons of iron were melted, and little or no maintenance was required.

The main results were as follow:—This single pipe exerted a considerable beneficial influence on the brickwork over three to four courses, reducing erosion substantially. The pipe was frequently

exposed whilst the cupola was in operation and yet did not show evidence of much attack. Substantial slag build-up on the pipe did not occur until the seventh day of the trial. Reference to Fig. 13 shows that erosion after the third day remained at an average value of 7 cub. ft. until the twelfth day, when "cutting" by molten iron caused failure of the pipe. This erosion was considerably less than that with the 70 per cent Al_2O_3 brick, *viz.* 11 cub. ft. after seven days, or with ordinary firebrick, 11 cub. ft. after three days.

Several small subsidiary effects were observed, including the correlation of temperature fluctuations with variations in the mains water-pressure, and the sensitivity of the water outlet-temperature to quite small changes in the air volume delivered, changes of the order of 100 cub. ft. per min. produced corresponding changes in temperature of up to 3 deg. C. in the water. No effect on metal temperature was observed.

A further set-up, as shown in Fig. 11 and consisting of three cooling rings, was then installed as follows:—The rings all 1-in i.d. were embedded in the firebrick lining at intervals designed to cover completely the zone of erosion. They were fed from a manifold connected to a header ring, each ring having its rate of water flow controlled from the manifold. The outlets all discharged into a common bosh. The rings were rammed in and around with ganister and the lining was dried. The cupola was put into operation, using a water flow of twelve galls. per min. through each ring. The trial lasted over seven melts and Figs. 12 (*a*) and 12 (*b*) show how the erosion progressed from the first to the seventh melt, the pipes standing completely proud from the lining from the fourth day onwards.

Main Results

The trial gave the following main results:—

(*a*) After the first day's operation, all the cooling rings were almost standing "proud" from the brickwork. The rammed ganister had eroded away, and the brickwork had been removed back to the rings.

(*b*) The brickwork above, below, and between the rings was well glazed and after four days' operation very little erosion had occurred, the cumulative average erosion being only 6 cub. ft. (see Fig. 13). The rings by the fourth day had collected a substantial slag coating.

(*c*) The exposed rings protected the brickwork behind them very well, but appeared to cause bridging of the cupola in front of them, especially after the shut-down for the mid-day meal. This was attributed to cooling slag flowing over the cold rings, and freezing, thus initiating a slag bridge which formed during the afternoon's run. Reducing the water flow to nine galls. per min. increased the outlet temperature and minimized the trouble.

(*d*) The slower melting rate also was attributed to reduction in area of the melting zone by the slag bridge.

(*e*) After the fourth day's operation, the rings began to sag because of their unsupported state.

(*f*) Metal temperature was unaffected by the water cooling and remained approximately constant throughout each day's operation.

(*g*) The rings were removed after the seventh day's operation, because of the sagging and, after removal of the slag coating, were found to be practically unaffected.

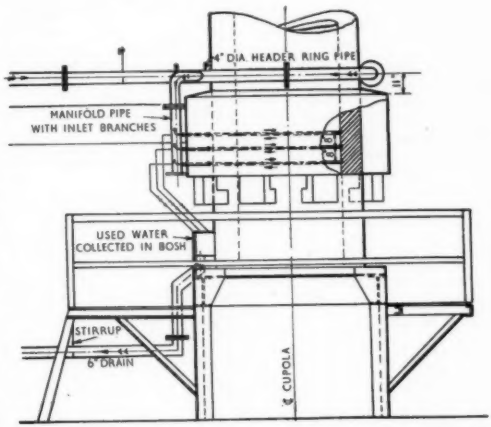


FIG. 11.—*Sketch of a cupola base incorporating three cooling rings of the type shown in Fig.* 10.

Future Prospects

These results suggested that this method of water cooling could be applied in normal practice, providing the rings are bricked—not rammed—about 1 in. to 1½ in. behind the working surface of the lining, using a good-quality brick of high thermal conductivity. The ganister ramming in which the rings were initially embedded, had quickly eroded, due probably to poor thermal-conductivity and this initiated the brickwork erosion which exposed the rings. The ramming is therefore the weak "link" in the method. With a bricked-in ring, the first day's operation should be of a mild nature to allow slag to glaze the working surface of the lining. It may then be envisaged that a state of equilibrium would be reached before the rings could become exposed, and hence, a cooled working face would always be presented, full benefit thus being derived from cooling. As shown by the trial, the brickwork behind the pipes was protected, the effect of the rings in the front being to cause bridging, erratic operation and slower melting. It is remarkable to observe how long an exposed, water-cooled ring can exist in the melting zone of a cupola during operation.

A third series in these water-cooling experiments has now been started in which slightly modified cooling rings bricked into a 70 per cent. Al_2O_3-brick lining will be used, with provision in the future for a similar set-up using a rammed, monolithic carbon-lining. However, more "field work" has to be done to assess accurately the value of a rammed carbon-lining. Research to find a suitable material for the taphole and cupola bottom to

withstand five-day-a-week operation without dropping the bottom is under way, and it is felt that the aim, although not yet realized, is at least within sight.

To summarize the effects of linings and water cooling in terms of erosion, reference to Fig. 13 shows that for firebrick approximately 14 cub. ft. of erosion had occured (including patching material) in four days, whilst with 70 per cent. Al_2O_3 bricks the figure was 11 cub. ft. in seven days without any patching. A single, water-cooling ring embedded in a firebrick lining gave an average of 7½ cub. ft. up to eleven days, whilst three cooling rings, in conjunction with firebrick gave 8½ cub. ft. after seven days, taking into account that the premature erosion of the rammed ganister had quickly exposed them.

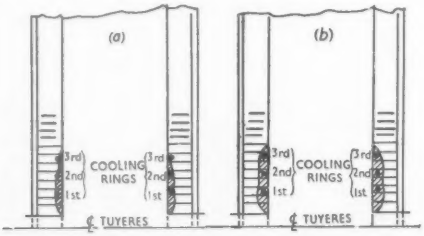


FIG. 12.—*Cupola-erosion contours (a) after the first day and (b) after seven-days' operation with the water-cooling system shown in Fig.* 11.

CONCLUSIONS

(1) Investigation and experiment on cupola plant at the company with which the Author is associated, on such variables as combustion conditions, optimum charge-weights, charge distribution, and lining erosion have enabled a controlled method of cupola operation to be evolved. Advantages include a considerable saving in melting costs per ton of metal produced, together with metallurgical improvements, such as, hotter, cleaner metal, the temperature fluctuation throughout the day being reduced from 50 to 10 deg. C., a substantial increase in the melting rate and reduced slag volume. Lining erosion was reduced from an average of 11 to 13 cub. ft. to 3.5 to 5.0 cub. ft. per run and was consistent and even in its effect. The metal:coke ratio was increased from 7:1 to 9.5:1. The cupola plant is now controlled to suit the varied requirements of the foundry, ranging from hematite ingot-mould to jobbing, engineering castings.

(2) Trials on both carbon and 70 per cent. alumina bricks as lining materials were carried out. The results obtained with the former included more-basic slags having increased fluidity. There was no metallic iron detected in them, and the total FeO and MnO content was approximately half that of the normal slag—about 7 per cent. as against 13 to 15 per cent. An important result of this differing slag composition was reflected in a lower sulphur-content in the metal 0.064 per cent. as against the usual 0.09 to 0.10 per cent. It is felt that carbon as a lining material has certain possibilities providing it is rammed monolithically and not used in the form of bricks. Bricks of 70 per cent. alumina content were successful metallurgically, giving a considerable reduction in maintenance, a reduced slag-volume (with a consequent saving in limestone of approximately 35 per cent.) and increased heat efficiency from the coke. The slagging periods were reduced, and the slag carried was of a desulphurizing nature. Economically, however, the high cost of the brick as compared with firebrick outweighs these metallurgical benefits.

(3) A simple method of water cooling the cupola gave promising results, little or no maintenance being required over the period of trial. Erosion was reduced considerably, a cumulative average over eleven days for one cooling ring being only 7½ cub. ft. total, whilst when three cooling rings were employed the figure was 8½ cub. ft. total over seven days. This latter result takes into account rapid exposure and sagging of the pipes due to failure of the ganister ramming.

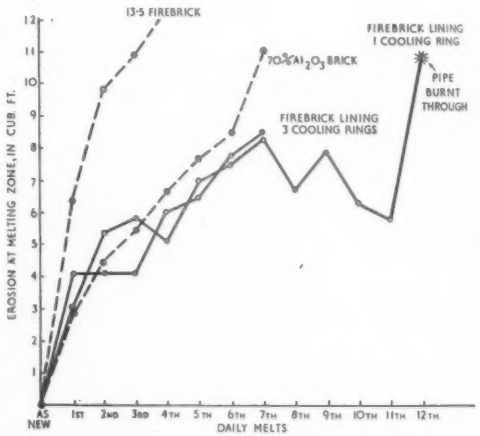


FIG. 13.—*Cumulative wear at the melting zone of cupolas with various linings, with and without water cooling.*

Acknowledgments

The Author wishes to thank Mr. T. Jolly, joint managing director, Guest Keen Iron & Steel Company Limited, and Mr. E. M. Yorath, works manager, of that company's Ivor Works, Dowlais, Glamorgan, for permission to write this Paper, Mr. N. Gray, M.Met., chief metallurgist, Guest Keen Iron & Steel Company Limited, for help and criticisms during its preparation, and his colleague Mr. J. R. M. Richards, B.Sc., L.I.M., for his valued help in the "field" work, and for the various illustrations and graphs presented.

The first president of the Manchester College of Technology will be Lord CHANDOS, chairman of Associated Electrical Industries, Limited.

Servicing Domestic Solid-fuel Appliances

The British Ironfounders' Association have detailed a scheme, whereby solid-fuel appliances are to be better serviced in the future. This will come into operation on August 1, with the creation of an "A" list of merchants who will receive a discount of 30 per cent. instead of 25 per cent. as previously. To qualify, these merchants must adhere to 12 requirements. These qualifications include correct installation and thorough supervision by a competent member of the merchant's own staff. (Here it might be suggested that the word "competent" should be replaced by "qualified," this qualification to be based on attendance at one of the excellent courses organized by the Coal Utilization Council.) Other qualifications include the recommendation of a reliable trade fixer; fixing by the merchant's own qualified range fixers; the provision of competent advice to the prospective purchaser as to the appliance best suited to the purchaser's requirements; supplying information on the correct types of fuel to be used in the appliance; and liaison with local coal merchants so as to keep fully informed of the fuel supply position, particularly with regard to the fuels required by selective appliances.

The merchant must also be prepared to inspect and give expert advice on new appliances supplied by him up to six months from the date of installation, and ensure that showroom salesmen and representatives are fully conversant with all features and developments of appliances which they sell. Attractive permanent window and showroom displays of modern solid-fuel appliances covering open fires, openable stoves, free-standing cookers, combination grates and independent domestic boilers must be arranged, and unless physical conditions render it impracticable, at least one appliance must be shown under fire for demonstration purposes.

The association estimates that about 1,200 merchants will qualify for the increased terms.

It will be appreciated that these additional margins to cover the increased cost of services must be reflected in the prices to the general public, and unfortunately costs of raw materials and transport have also increased considerably in recent months.

It is therefore necessary, in introducing these arrangements, to increase prices by 7½ per cent, but adjustments have been made in the terms to housing authorities and nationalized industries to ensure that the prices to such authorities are only increased by the minimum necessary to cover the increases in costs of raw materials and transport.

"Scrap Investigation"—Correction

Mr. J. McGrandle, the author of the Paper "Scrap Investigation," published in the JOURNAL, July 5, points out that the blocks for Figs. 3 and 4 have been interchanged. Fig. 3 should indicate the defect chart prepared by Mr. Sumner and Fig. 4 a simplification of the chart possible if gating and risering systems moisture, green-strength and permeability of sand could be standardized and thus eliminated as causes of defects.

Films on Work-Study. The industrial section of the Central Film Library announce the issue of a number of films covering the important subject of work-study. The list can be obtained by writing to the library at Government Building, Bromyard Avenue, Acton, London, W.3.

Basic Materials Prices Fall

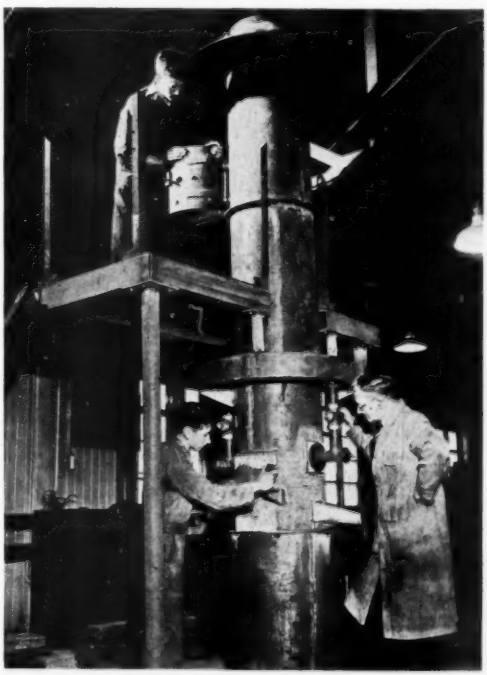
There was a slight fall in the index of prices of basic materials in June, which, at 155.2, was almost exactly the same as in December, 1955. Prices of materials used in mechanical engineering fell slightly during the month and are now almost at the same level as in December, 1955.

The prices for materials used in electrical engineering again fell sharply in June—mainly because of the drop in copper prices—and are now almost back to the level of a year ago.

The index for the price of fuel used in manufacturing industry jumped 4.6 per cent. in June, because of the 8 per cent. increase in the pithead price of coal and the consequential increases in the prices of coke, gas, and electricity. This index is now 17½ per cent. higher than in June, 1955.

STEEL OUTPUT in Germany during June reached a record daily average of 73,140 tons, production for the month amounting to 1,914,000 tons, against 1,793,000 tons in June last year. In the first six months of this year output totalled 11,299,000 tons, against 10,285,000 tons in the corresponding period of last year, an increase of slightly less than 10 per cent.

The illustration shows a 12-in. diameter cupola, built by the constructional engineering apprentices at Newton Chambers & Company, Limited, Thorncliffe, as an exercise and installed by them in the foundry section of the North Lindsey Technical College, near Scunthorpe.



Private Industry and Prices

Following the lead given by the Government and the nationalized industries in their endeavours to create a period of price stabilization, four organizations representing 90 per cent. of private British industry are appealing to their members to restrain prices. At a Press conference in London the Association of British Chambers of Commerce, the British Employers' Confederation, the Federation of British Industries, and the National Union of Manufacturers issued a joint statement saying that they felt the moment had come when private industry could and should play a special part in defeating inflation. While the urgent need remained for resolute action in reducing public spending, the Government's measures to stop inflationary pressure at its source, slow at first, appeared now to be having some effect. As the nationalized boards had announced measures to stabilize their prices for some time ahead, private industry should try to do the same, said the statement.

Sir Graham Hayman, president of the FBI, who presided over the meeting, said that he believed this united action to be unique in industrial affairs. "It reflects our determination not to allow an opportunity to slip by to defeat inflation, for we know that if it is not defeated, all in industry—employers and workpeople alike—will suffer hardships far greater than any that are involved in arresting it," he said.

Wholesale Price Index Numbers

The present Board of Trade index numbers of wholesale prices is to be replaced by a new series taking average prices in 1954 as base 100. The change will be made from a date in 1958 to be announced later. Announcing the proposed changes, the Board of Trade states that the present series take as their base prices ruling at June 30, 1949, and the weights used reflect the pattern of sales of manufactured products and use of raw materials in 1948. The full results of the census of production for 1954 will make it possible to use for weights the pattern of sales of manufactured products and use of basic materials in that year.

Pointing out that it is desirable to keep the structure of the index numbers as up to date as possible, the Board of Trade states that 1954 is felt to be specially suitable because most prices, after falling from the high levels during the Korean war, were comparatively stable. In order to help firms which may conclude contract prices to take account of changing raw material costs and give some measure of continuity between the current and new series of indices, the Board is prepared to consider publishing on the current base certain of the index numbers for a period of 12 months after the new series is introduced.

Midland Aluminium Circular

Shareholders of the London Aluminium Company, Limited, are urged by Major C. R. Dibben, chairman of the Midland Aluminium Company, Limited, in a circular to vote for the appointment of Mr. J. A. Orme to the board of London Aluminium at the meeting on July 27.

The meeting was requisitioned by Midland Aluminium (owners of one half of the equity of London Aluminium), and Major Dibben says a majority is already assured. He says that the potentiality of ultimate control by Midland was clearly implicit in the 50 per cent. shareholding which has always been entirely unrestricted.

Strengthening Factory Inspectorate

Proposals to increase the number of factory inspectors by such stages as were practicable in relation to recruitment and absorption were announced by Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour and National Service, on July 16. The strength of the engineering and chemical branch was to be increased from 18 to at least 44, which subject to further consideration in detail, would enable the Minister to station one engineering inspector and one chemical inspector in each division. There was also to be some reinforcement of the general inspectorate to enable inspectors to pay more attention to building operations and works of engineering construction.

In opening the debate, Mr. Frederick Lee (Lab.) had urged the Minister to consider a large increase in the strength of the inspectorate, declaring that to double the force would by no means be too large. Mr. Carr said that excluding certain senior posts at headquarters, the authorized strength of the general inspectorate was 322 and at last virtually at full strength. The time had come to consider whether the establishment was adequate and to consider the future, but he did not associate himself with any target such as doubling the size of the inspectorate.

Declaring that it was a matter for concern that since 1952 the downward trend in the number of reported accidents had ceased, although allowance should be made for the increased number of people at work, the Parliamentary Secretary thought that works safety committees were the way in which to express most effectively the desire and determination to do something about the prevention of accidents in factories and workplaces. The accident rate for boys and girls had not fallen in recent years and this was particularly disturbing when the next few years would see an increasing number of young entrants to industry.

British Industry for Australia

Several new British industries are likely to be established in the State of Victoria. This forecast was made by Mr. H. E. Bolte, Premier of Victoria, on his departure for Melbourne following a three-week mission to tell British industrialists of Victoria's potentialities.

Types of British industry now contemplating establishing or expanding themselves in Victoria, according to Mr. Bolte, include the machine-tool, air-conditioning and heating, foundry, and heavy earth-moving equipment industries. "In addition," he said, "we have every assurance of a substantially increased investment programme." Referring to redundancy prospects in the British labour market, he said that those industrialists who had decided to branch out in Victoria had been inundated with requests from their employees to go there.

Mr. Bolte previously spent several weeks in the United States on a similar mission, and he reported an equal degree of enthusiasm among American industrialists.

WICKMAN, LIMITED, machine-tool manufacturers, of Coventry—Dividend on the ordinary shares for the year ended March 31 is raised to 17½ per cent., tax free, from 15 per cent., tax free, for 1954-55. Group profits rose to £519,594, from £382,419, after deducting tax of £696,495 (£638,660 and after crediting loss of profits insurance payment of £46,386).

Fundamentals of Shell Moulding

*By P. H. R. B. Lemon**

Shell moulding is a method of producing metal castings in which a shell or "biscuit" of sand bonded with resin is used in place of the normal foundry moulding sand. Many papers have been written on this relatively new process, but hitherto no serious attempt has been made to present and explain the fundamentals of the shell-making technique. The object of this article is to describe what is known of the actual behaviour of the sand/resin mix during the process and the influence of basic sand and resin properties in the making of the shell.

Shell Making

In the shell-making process a moulding mixture is first prepared by blending sand and powdered resin in the correct proportion (usually 4 to 10 per cent. resin) in a suitable mixer. This is placed in a container known as a "dump box" at the open end of which is fixed the hot pattern, the surface of which it is desired to reproduce. By inverting the dump box, the shell-moulding mixture is dropped on to the pattern. The resin adjacent to the pattern melts, cures and bonds the sand together. After a given interval of time known as the "investment time" the box is turned back and the moulding mixture which has not bonded to the hot pattern falls back into the box. The crust of resin-bonded sand is then fully cured by placing the pattern in an oven. After cure, the shell is stripped from the pattern by ejector pins. Thus the shell-making process may be summarized in the words:—mix, invest, revert, cure and eject.

Mixing

If mixing of the sand and resin particles is insufficient, variable performance of the moulding mixture will result.

Investment

The thickness of shell produced on investment is dependent upon the temperature of the pattern, the time of investment, and the flow properties of the resin used. For a particular casting, it is necessary to choose a thickness of shell sufficient to contain the metal during the solidification period but thin enough to be economical.

Reversion

On reversing the dump box, it is sometimes found that part of the shell which has not cured but is merely in the thermoplastic state peels off the cured portion of the shell. This is known as "peel-back." Peel-back can be divided into three types:—(1) "Peel off" where the shell moulding mixture actually peels from the pattern surface; (2) "strata peel-back" where the resin/sand mix peels off across the line between the strata of cured and uncured resin, and (3) "incipient peel-back" where the moulding mix exhibits slight gaps at the line between cured and uncured strata but has not actually peeled off.

Curing

The pattern is placed in an oven so that heat is supplied to the uncured back of the shell. Curing is accompanied by a colour change from grey to yellow to light brown.

Ejection

If, after cure, the resin remains even only slightly thermoplastic it is likely to deform on ejection. This makes it difficult to match up shell halves and produces dimensional errors in the final casting. In particularly bad cases of thermoplasticity, it is actually possible to fracture the shell during ejection.

It is thus possible to summarize the performance of the ideal shell-moulding mixture in the following statement:—It must give the desired "investment rate," exhibit no "peel-back," no thermoplasticity and give a shell of the desired tensile strength, scratch hardness, surface finish and permeability.

Moulding Mixtures

Moulding mixtures used in shell moulding can be divided into three distinct types:—(*a*) Dry powder resin/sand mixtures; (*b*) cold milled powder resin/sand mixtures; and (*c*) pre-coated sand. The difference between these three types may be diagramatically represented as in Fig. 1. In (*a*) the only adhesive force holding the resin particles to the sand grains is a slight electrostatic charge; in (*b*) the powder resin is made to adhere to the sand grains, and in (*c*) the process is carried to the limit, when the sand grains are actually coated with a thin layer of resin.

Sand/Resin Grain Orientation and the Ideal System

When bonding sand grains together with resin, it is necessary to consider what would be the ideal system, *i.e.*, the system which would give the highest tensile strength and maximum efficiency of resin. One must first assume all sand grains to be spherical and uniform in size. When a volume of ideal sand grains in a stationary state is examined they will be found to fall into a hexagonal close-packed structure as in Fig. 2. An ideal orientation of resin and sand grains would place a resin grain between each sand/sand interface so that, on heating, the resin would flow into a meniscus, cure, and a completely bonded network would result. Thus,

*The Author is attached to the research laboratories of Leicester, Lovell & Company, Limited, Southampton.

Fundamentals of Shell Moulding

in an ideal system, the ratio of number of resin grains to sand grains must be at least 1 : 1.

Comparing this ideal system with that found in practice, no shell-moulding sand has a constant grain size or a spherical grain shape, so that points of contact between grains will be irregular and the formation of voids or faults in the structure will be quite frequent. It is impossible in practice to arrange resin particles between each sand/sand interface. The majority of the resin particles will be found in the interstices between grains, where the possibilities of reaching a sand/sand interface during the flow period will be remote. This explains

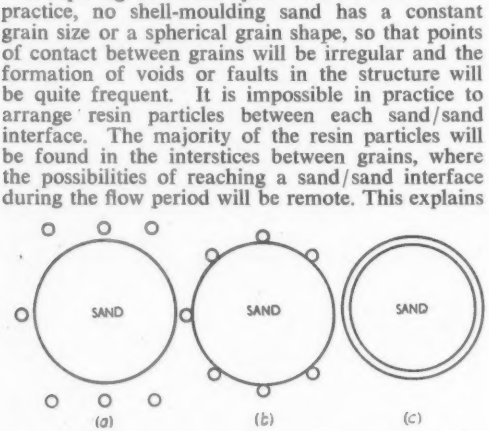


FIG. 1.—*Diagrammatic representation of the three types of shell-moulding sand: (a) dry-powder resin/sand; (b) cold-milled powdered resin/sand, and (c) pre-coated sand.*

why cold-milled sand gives higher tensile strengths for the same resin concentration than the dry powder resin/sand mix. The particles of resin are bonded to the surface of the grain and cannot collect in the interstices between sand grains. Actually, the electrostatic charge on resin grains does tend to give a similar effect in dry powder resin/sand mixtures, but not to such a marked extent.

In pre-coated sand there is always a film of resin between sand/sand interfaces so that on curing a very strong network is built up, although the effect of irregular grain size and shape and the resultant formation of the voids is still felt. Using any of the three bonding systems, sand of larger grain or resin of smaller grain will improve the efficiency of the final network. In the former case, the ratio surface-area : bond is reduced and in the latter the distribution of the resin is improved.

Practical Support

In practice, the following facts, which seem to be well in agreement with the foregoing ideas, are observed :—

(1) Sands of roughly spherical grain shape give higher tensile strength in the shells than sand of angular grain, for the same resin concentration.

(2) Sands of large grain-size give higher tensile strength than that having small grain-size. There is a limit to this effect, but it lies outside the range normally used for shell moulding.

(3) Similarly, reduced particle-size for the resin gives improved tensile strength.

(4) Pre-coated sand gives shells of higher tensile strength than cold-milled sand, which in turn is more efficient than dry powdered-resin/sand mixtures for the same resin concentration.

The presence of impurities, such as water or clays, has been found to produce shells of poor strength. Large-grain sands, although giving high tensile strengths, give poor surface finish, so that when choosing a shell-moulding sand it is necessary to balance tensile strength against surface finish. Blends of large- and small-grain sands, such as 50/50 Redhill F and Redhill H, are often used in practice.

Rheological Properties of Shell-moulding Resins

Having considered the spatial arrangement of sand and resin grains and its influence on the strength of the final cured shell, it is necessary to examine the basic properties of resins used in the shell-moulding process, in order to determine the effect these have on shell making.

Shell-moulding resins are usually of the two-stage phenol- or cresol-formaldehyde novolac type. When the resins are ground, they are then admixed with powdered hexamine. In a shell-moulding mixture, there are separate grains of novolac and hexamine. On the application of heat, the novolac melts and the hexamine sublimes, so that the novolac cures in a vapour of sublimed hexamine.

Flow and Reactivity

Considering a particle of resin on a sand grain, on the application of heat the resin melts and flows until the vapour of hexamine has reacted sufficiently to cause gelation, whereupon the resin ceases to flow. Let the distance flowed during this period be called "flow" and the time interval between application of heat and gelation be termed "reactivity." These conditions can be roughly duplicated in the laboratory by employing a novolac/hexamine mixture on an inclined hot plate. The following is a simplified theoretical interpretation of the influence

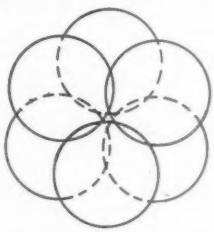


FIG. 2.—*Hexagonal close-packed structure resulting from spherical grains.*

of flow properties of the resin on its behaviour in shell making. (Fig. 3 indicates the influence of flow and reactivity of resins on their performance in shell moulding.) When two sand/sand interfaces are bonded with resin, the tensile strength of the bond obtained is dependent upon :—(1) The surface area bonded; (2) the size and cohesive strength of the bonding meniscus, and (3) the specific adhesion between sand and resin. Under conditions of perfect physical contact between resin and sand, it is assumed that factor (3) is independent of the flow characteristics of the resin so that factors (1) and (2) alone influence the bond.

As shown in Fig. 3, a resin having a long " flow " forms a thin meniscus because of drain-away of resin from the point of contact. This results in poor adhesion. A resin of medium " flow " allows a meniscus of maximum size to be formed, giving good tensile strength. When " flow " is short, the resin particle does not flow sufficiently to take up a meniscus form; the area of contact is thus small and the tensile strength poor.

It should be understood that " flow " and " reactivity " do not exist as separate entities, but are combined in what is termed the rheological curve. This is a plot of viscosity against time, examples of which are shown in Fig. 4, corresponding to four of the conditions indicated in Fig. 3.

It is possible to relate investment rate to these curves. When the temperature of a particle of

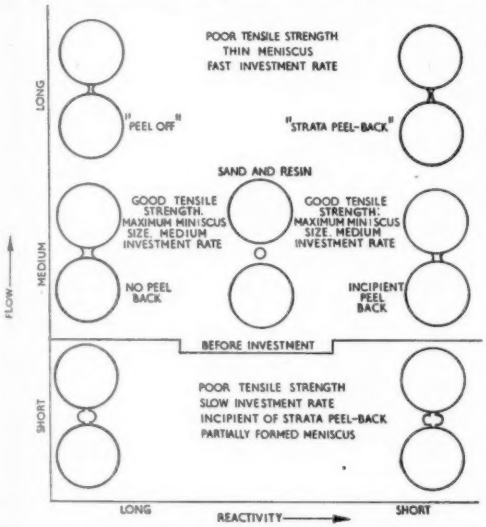


FIG. 3.—*Influence of " flow " and " reactivity " of resins on their performance in shell moulding.*

resin is raised, its viscosity falls until a point is reached when the meniscus between sand grains is sufficiently formed to hold the weight of at least one grain of sand. Let it be assumed that a viscosity of x is required to achieve this condition, then from the curves it is apparent that a longer time is required to reach this condition for a short-" flow " resin than in the case of a long-" flow " resin. Thus the investment rate of a long-" flow " resin is faster than that of a short-" flow " resin.

Peel-back

The phenomenon and classification of peel-back has been described previously. The rheological behaviour of a resin determines whether it will exhibit peel-back. Peel-back is always observed to take place very close to the barrier between gelled and ungelled resin. It is safe to assume that peel-back always occurs when the resin is at the point of minimum viscosity, because here the ratio of shearing force between grains (*i.e.* weight of shell acting at the point in question) is greatest and the bonding force (*i.e.* resin viscosity) weakest. Thus, resins having long " flow " will show more peel-back than resins of short " flow " (Fig. 4) because of their relative minimum viscosity points. " Reactivity " dictates the type of peel-back which can occur, *i.e.*, " peel off " when " flow " is long and " reactivity " long, strata peel-back and incipient peel-back when the " reactivity " is short.

It is realized that this interpretation is extremely simplified, since here the resin is considered to be at constant temperature, while in practice the temperature of the resin in any part of the shell is far from static. However, laboratory investigations have shown that it is possible to relate rheological properties of the resin with the investment rate, peel-back, and tensile strength of the resultant moulding mixture, in such a fashion as to verify the above theory.

Thermoplasticity

Novolac resins when cross-linked with hexamine pass through a " Baekeland B " stage, when they are slightly thermoplastic. This is the cause of many distortion problems when cured shells are ejected and in the casting stage. From this particu-

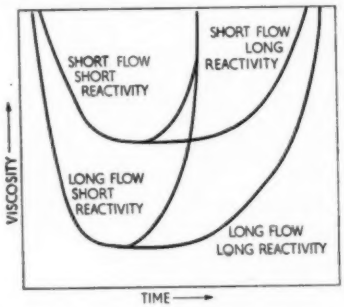


FIG. 4.—*Rheological curves, combining " flow " and " reactivity " for the four conditions indicated in* FIG. 3.

lar aspect, novolacs possessing a very short " Baekeland B " stage are most suitable for shell moulding.

Conclusion

It is hoped that the foregoing has given some insight into the fundamentals of the shell-making technique. Obviously a great deal of work has yet to be done before the ideal moulding mixture is obtained. However, by examining the fundamentals of the process, it has been possible to improve the standard and efficiency of the production of shell moulds. The use of new sands, new resins, pre-coating and cold-milling techniques is now being widely practised.

Borax Consolidated, Limited, announces the appointments of Mr. C. M. HOULTON as general sales manager and Mr. A. G. H. BELL as assistant sales manager.

Kariba Orders for Italy

Italian engineering concerns have secured the two most valuable contracts associated with the Kariba Gorge hydro-electric power scheme in Southern Rhodesia. Together, the two orders are worth more than £35,000,000. Six British engineering concerns will share contracts worth about £5,000,000, while an Italian company erecting the initial transmission system will spend about £4,000,000 on British equipment.

The main civil engineering contract will go to Impresit (Kariba) (Pvt.), a new company to be formed by four Italian groups in association with South African and Rhodesian subsidiaries. The group's price of £25,278,000 was £1,466,000 less than the next lowest tender. Rhodesian Power Lines (Pvt.), the Rhodesian counterpart of Societa Anonima Elettrificazione, of Milan, had its tender of £9,935,844 for 925 miles of 330-kv steel tower transmission lines accepted. The company has stated that it will use considerable quantities of British equipment, probably to the value of £4,000,000.

The six British concerns which were successful in their tenders for equipment for the scheme were:—Metropolitan-Vickers Electrical Export Company, Limited, Manchester, £1,772,065 for five three-phase 100-mw water turbine-driven generators; Ferranti, Limited, Hollinwood (Lancs), £1,333,200 for 13 three-phase sub-station transformers; Boving & Company, Limited, London, W.C.2, £1,072,583 for five 140,000 b.h.p. water turbines; English Electric Company, Limited, £622,500 for 10 single-phase generator transformers; C. A. Parsons & Company, Limited, Newcastle-upon-Tyne, £191,920 for shunt compensating reactors and accessories; Babcock & Wilcox, Limited, London, E.C.4, £108,292 for two overhead electric travelling four-motor cranes, each with 200-tons lift capacity, for the underground power station. A temporary power plant of some 6,000 kw and certain other constructional plant will also be obtained from Britain.

Profit-sharing Methods

Four general methods of profit-sharing were described by Mr. D. B. Tracey in an address to the Industrial Co-partnership Association at Cambridge. The speaker emphasized that one of the most important things in profit-sharing was to get the right type of scheme. The choice could not be made unless one knew what was available. Under the first method employees received a bonus linked to the ordinary dividend rate. Though widely adopted because the idea was simple, Mr. Tracey said the method was inherently defective. The main difficulty arose when the capital was altered, perhaps by a scrip issue, and the rate of ordinary dividend, and consequently the bonus, reduced.

This problem, he said, could be overcome by the second method which gave employees a percentage of the total distribution among ordinary shareholders. But neither of these methods aroused much interest in employees and another drawback was that they directed employees' attention to distributed profits which were not a satisfactory indication of the results. The third method—the distribution to workers of a percentage of profits—was more popular with employees and it was agreed that the basic idea was sound. Difficulty arose in deciding what was to be regarded as profits available for distribution.

Under the fourth method, employee-shareholders were paid a larger dividend than other shareholders. An employee with shares in the company received a bonus proportionate to the dividend.

Law Cases

£3,500 Settlement in Furnaceman's Claim

At Staffordshire Assizes on July 10, settlement of £3,500 was reached in a claim brought by Mr. John Thomas Garbett (36) against a steelfoundry firm at Wednesbury. Garbett claimed for personal injuries received in an accident at the company's works when he was burned by molten metal. He alleged negligence and breach of statutory duty. Giving evidence, officials of the firm denied that furnaces were being overloaded and heating forced to maintain a high output of steel. For Garbett, Mr. E. Ryder Richardson had alleged that a furnace was overheated and Garbett could not get clear because his escape route was blocked on both sides. A Birmingham furnace expert said that it appeared the roof of the furnace had collapsed, owing to excessively high temperature.

Mr. W. L. Beasley, foundry superintendent of the firm, said that the furnace had produced about 200,000 tons without mishap. He said that he had inspected the furnace the weekend before the accident and had found that the roof was in good condition. The capacity of the furnace was ten tons, but it held anything from eight to 15 tons. On the day of the accident there were 10 tons of metal in it. Mr. Beasley denied that the furnace was being forced to increase output or that it was being run at excessively high temperatures. Cross-examined, he agreed that in 1951, when the accident occurred, output of steel was going up. He said, however, that the firm had capacity for producing more than they were making. Annual capacity was about 55,000 tons but they were producing about 48,000 tons. Announcing that a settlement had been reached, Mr. Richardson said that an undertaking had been given by the firm to continue the man's employment on the same terms and conditions as at present.

Slinging Machine Accident

Damages of £750 were awarded at Salop Assizes to W. J. Mannering (33) in a claim against his former employers, a foundry firm at Ketley, alleging personal injury and negligence. It was stated that Mannering had been about to operate a sandslinging machine on February 23, 1953, when a piece of scrap metal flew out of it and cut his eyebrow. His nervous system had been disturbed and he still suffered from headaches. He resumed work at the foundry eight weeks after the accident but could not stand the noise of machines and had to leave. A fitter, Thomas Eric Poppett, said that, following a complaint, he examined the machine. He went away to get some tools, shouting to the operating team not to use the machine until he returned. He was away for just over a minute, during which time the accident occurred. Mannering denied having been told not to use the machine. Mr. Justice Lynskey said he accepted Mannering's evidence.

ACCORDING TO provisional figures issued by the High Authority of the European Coal and Steel Community, steel production in the six ECSC countries in June reached 4,842,000 tons. This was 3,000 tons more than the previous record set up last March and 366,000 tons more than the total for June last year. German and Belgian production during the month was slightly below the March peak, but output in France, Italy, and Luxembourg was at a record level. Production of pig-iron and ferro-alloys during the month was 3,717,000 tons, an increase of 44,000 tons over the March record.

Flange and Body Patterns

By "Tramp"

One part of a pattern has often to be secured to another by means of dowels to ensure correct registering. Although apparently a simple matter, a little thought on the part of the patternmaker can often save the moulder a considerable amount of time in correctly locating the dowelled piece.

For example, Fig. 1 shows a loose flange which has to be dowelled to a body, forming the middle portion of the pattern of a winding drum. If dowelling is done by the conventional method, difficulty is often experienced by the moulder in locating the flange, as he is working "blind." A method of locating two pieces such as these, is to turn a spigot on the body and a hole through the flange as shown in Fig. 2, as it is much easier for the moulder to slip the flange over the spigot than to endeavour to find the two dowel holes in the body.

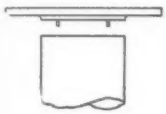


FIG. 1

FIG. 2

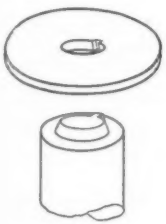


FIG. 3

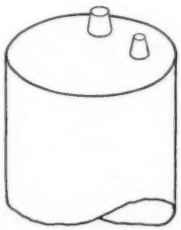


FIG. 4

FIGS. 1 TO 4.—*Location of flanges on body patterns.* FIG. 1.—*Loose flange dowelled to a body, necessitating "blind" location.* FIG. 2.—*Improved method, using a large spigot on the body.* FIG. 3.—*Recommended means for securing a set relationship between body and flange.* FIG. 4.—*Method best suited to large flange-and-body jobs.*

If the top flange had to register in correct location with some detail on the body, a dowel could be placed so as to ensure its fitting, one way only, but this again is working blind. A better way would be to cut a slot through the flange and place a projection on the body as shown in Fig. 3.

When the job becomes larger, as for instance a flange of 6-ft. dia. on a 4-ft. dia. body, two large wooden dowels projecting through the flange piece, as shown at A and B, Fig. 4, will be found to be suitable. These are of different sizes, say 1½- and 2-in. dia. They have a generous taper and are so located that the flange can only suit one way. Because they penetrate the flange, the moulder can see them when placing the flange in position and more readily assemble the whole.

Chinese Side-blown Converter Practice*

At the present time, the Chinese are producing about 15 per cent. of all their steel in side-blown converters, mainly in the works listed in Table I. In addition, there are side-blown converters in plants at Chungking producing about 100,000 tons per year. The use of side-blown converters in China originated during the Japanese occupation but was rapidly developed by the Chinese Peoples' Republic. The main reasons for the development of these small converters were:—(*a*) insufficiency of scrap supplies for open-hearth production; (*b*) the side-blown converter is independent of blast furnaces; (*c*) possibilities exist of operating with cupolas using up to 20 per cent. scrap; and (*d*) availability of ore suitable for producing low-phosphorus iron.

To-day, the Chinese are using side-blown converters with basic linings so that they can work with normal open-hearth quality iron which is cheaper than Bessemer iron. These plants are all identical. Carbon steels of 0.06 to 0.10 per cent. carbon are produced and deoxidizers are added before tapping into the ladle (ferro-manganese, ferro-silicon and aluminium being used); six tons of metal are poured in two minutes.

TABLE I.—*Location, Type, and Capacity of Chinese Side-blown Converters.*

	Shanghai plant.	Ta Yi works.	Tien Shan works.
Number of converters	5	2	6
Capacity (each)	3.8 tons	1.5 tons	6 tons
Lining	Acid	Acid	Basic
Annual production	100,000 tons	50,000 tons	200,000 tons

In 1952, the converters at the Tien Shan plant went over to using a basic lining made locally by a special mixing process from dolomite and magnesite. The Tien Shan plant was worked by a Japanese textile company until 1945 and then had two electric furnaces and an acid 4-ton converter with two 8-tons per hour cupolas. After 1945, a duplex process was used, with an electric furnace. The plant now consists of six 6-ton converters and four 8-tons per hour cupolas operating at 16 tons per hour daily total rate. The output in 1952 was 24,000 tons and in 1955 (November) 200,000 tons. The iron used is mainly of high-manganese content, the remainder of the charge being coke and lime. The yield of steel from the charge does not exceed 75 per cent. due to the low temperature of the cupola iron, also on account of high-manganese contents and pouring losses.

Small, basic side-blown converters are being developed in the Chinese Peoples' Republic and the process will be ameliorated by the practice of oxygen enrichment. There will also be a tendency to adopt the oxygen-enriched blast in bigger converters in conjunction with the use of the duplex (converter/electric furnace) process.

* Abstracted by R. Sewell from *Stal*, December, 1955, p. 1141.

Dr. CLYDE WILLIAMS, an eminent American scientist and research executive, will address the Trade Promotion Conference and second annual dinner of the Welsh Economic Development Council at Cardiff on October 12. Dr. Williams is the president and director of Battelle Institute, an international industrial research organization that is playing an increasing role in British technology.

Publications Received

Annual Report, 1955, of the British Coal Utilisation Research Association. Published by the Association, from Randalls Road, Leatherhead, Surrey. Price 10s.

This Report contains a wealth of information concerning the Association's activities. The early part is devoted to a general summary of the work of BCURA and its collaboration with its member firms and outside organizations, while the main body of the Report gives a detailed review of the research programmes carried out, and of the information made available to members and others through the publications of the Association.

Broadly speaking, BCURA's effort can be divided into two main categories: (1) practical research and development applied to the domestic and industrial utilization of coal and its derivatives and, (2) fundamental research aimed at increasing the chemical and physical knowledge of coal as a fuel and a chemical raw material. A close connection exists between the two since the fundamental resarch provides the background essential to the more practical work. Under heading (1), the Report lists many interesting programmes and results. The main investigations on boiler firing have continued to be centred on the need to burn a wider range of coals efficiently in industrial plant and, in this connection, the development of a modified chain grate has yielded encouraging results. The loan, by the British Transport Commission, of a Royal Scot class locomotive boiler has enabled the Association to proceed further with an examination of the problems involved in using small or inferior coals in such boilers. Work on combustion in cyclone systems has been continued, as has the programme on deposits and corrosion in boilers undertaken collaboratively with the boiler availability committee.

During the year, also, increased support from industry and plant manufacturers has been forthcoming for an extended investigation into gas-producer practice. On the domestic side emphasis has been laid upon the improvement of domestic heating, particularly in relation to the reduction of air pollution; the development of the small-pipe forced-circulation central heating system devised by BCURA was carried from the experimental stage to that of field testing. Research into heat balances in rooms continued, and the electrostatic precipitator for smoke measurement for domestic appliances was further applied.

Journal of Research and Development. Vol. 6, No. 5. Published by the British Cast Iron Research Association, Alvechurch, Birmingham.

The opening article, on the "Subversive Influence of Titanium and Lead in Nodular Cast Iron," by Mr. J. V. Dawson, corrects an earlier impression that 0.04 per cent. of titanium was the maximum to be tolerated when making this type of iron. Now the tolerable amount of this element can be of the order of 0.1 provided that no lead is present, as was the case in the earlier work. The second paper, by Mr. A. D. Lamb, deals with the "Effect of Section Size on the Quenching Sensitivity of Grey Cast Iron." The results obtained can only be regarded as indicative trends, as only single tensile tests were taken. The third paper, by Mr. W. E. Clarke, makes a survey of methods for slag control, most of the information available refers to steelmaking, and that relating to cupola practice is meagre, especially that covering visual and optical tests. Nevertheless, the paper is very interesting and worth careful study.

British Transport: 1955. Published by the British Transport Commission, 222, Marylebone Road, London, N.W.1. Price 1s.

The earlier part of the Report shows that the increase in receipts from fares on British Railways per ton/mile operated is much lower than the general increase in the cost of living over the period 1938 to 1955. Whilst the railways are "in the red," the Report gives some hope that with the modernization schemes now envisaged there will be a much better showing in the future. As is usual in the Commission's publications, the illustrations are excellent. The brochure is well written and will hold the attention of any reader interested in transport.

Overseas Newspapers and Periodicals. Published by the Publishing and Distributing Company, Limited, 177, Regent Street, London, W.1; price (with card cover) 7s. 6d.

For the foundry and foundry equipment industries, this list does not fulfil expectations, as the chief foundry magazines of France, USA, Spain, South Africa, and Canada, do not appear. Of course, it may be complete in other fields.

New Catalogues

Light Filters. A 12-page leaflet on this subject from Kodak, Limited, Kingsway, London, W.C.2, besides listing the types available indicates potential uses of various light filters in technical black-and-white photography. This, one can assume, applies also to macro and micro work with metal fractures and polished and etched sections. Perusal of the leaflet gives the reviewer the idea that a non-ferrous fracture viewed through a suitable filter might be capable of interpretation in terms of quality, but this may be jumping too far ahead. However, there is no doubt that photographic workers attached to foundries and research establishments will find much of interest in this publication—available from the address quoted above.

High-carbon Coke.—Charrington Gardner Locket (London) Limited, Tower House, 40, Trinity Square, London, E.C.3, have issued a folder covering V.f.T. high-carbon coke, which they are importing from Germany and marketing in this country. This is a very interesting piece of publicity and the claims made for ultimate economies when using the coke for foundry furnaces are striking. The possibility of reducing the coke splits in cupolas, higher temperature, reduced operating time, and the easy replacement of pig-iron by steel scrap, are amongst the advantages listed. This interesting folder may be obtained by writing to Trinity Square.

Ferro-alloys.—Ferro-alloys and electro-metallurgical products manufactured by the British Electro Metallurgical Company, Limited, Wincobank, Sheffield, are listed in a loose-leaf catalogue in a ring binder which will facilitate the addition of new pages or revisions. Essential data, such as atomic number and weight, density, melting point, conductivity, resistivity, etc., are given, in addition to specifications and sizes for each alloy or product, making the catalogue doubly useful for reference purposes.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

750,015. Philips Electrical Industries, Limited, Spencer House, South Place, Finsbury, London, E.C.2.

An anisotropic permanent magnet which has been subjected to the magnetic field while cooling through the Curie point. It is manufactured from an iron-base alloy containing Al 5 to 11, Ni 10 to 20, Co 10 to 25, Cu up to 7, and Si 0.2 to 3 per cent., the balance apart from the usual impurities being iron. The aluminium content is less than the nickel content; the silicon content is greater than 0.6 minus $\frac{1}{50}$th of the cobalt content.

750,095. Fulmer Research Institute, Stoke Poges, Bucks.

A method of making an alloy steel which is resistant to oxidation at high temperatures and ductile and normal temperatures. First, a melt is cast containing Cr 0.095 to 0.35, Si 1.5 to 5, and Al 0.1 to 5 per cent., the remainder being iron apart from the usual impurities. Secondly, the cast is subjected to hot or cold working or homogenizing heat-treatment or to both. The steel can be used instead of usual austenitic steels for moderately stressed applications, *e.g.*, furnace radiator baffles.

750,131. J. B. Brennan, 13018, Lake Shore Boulevard, Cleveland, Ohio, USA.

Apparatus for the continuous casting of metal, either in continuous lengths or as separate solid or hollow particles.

750,196. Mannesmann, A.G., 1b, Mannesmannufer, Düsseldorf, Germany.

A process for the continuous casting of iron or steel, which is stated to overcome the difficulties previously encountered in the use of oil as lubricant, arising out of the tendency for pores to form on the surface of the casting.

750,216. Millars Machinery Company, Limited, Thorley Works, Bishop's Stortford, Hertford, Herts, and L. A. Leach.

The manufacture of articles in metal or metal alloy by casting by pouring in a mould by a known method of dual casting. Partition means are provided in the mould to separate the different qualities of metal being simultaneously poured. In particular the invention is concerned with the production of drum rollers which have rims of a superior wear-resisting grade of iron while the main portion of the rollers comprise iron of an inferior quality, but the process is applicable to other articles.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

PAKISTAN, August 1—Measuring and testing instruments, for the Department of Supply and Development, Government of Pakistan. (ESB/17643/56.)

SOUTH AFRICA, August 9—Milling machine, for the Union Tender and Supplies Board. (ESB/18120/56.)

SOUTH AFRICA, August 10—Belt conveyor units, for the Stores Department of the South African Railways. (ESB/17872/56.)

Company News

C. C. WAKEFIELD & COMPANY, LIMITED—Referring to rumours that the company might be the subject of a take-over bid, the chairman, Mr. L. W. Farrow, quotes a paragraph from his 1954 statement, which said that none of these reports of amalgamation with, or absorption by, one of the petrol companies had any factual foundation whatsoever. Those remarks apply equally at the moment, he states.

EDGAR ALLEN & COMPANY, LIMITED—The continued advance in costs of plant and equipment, and the consequent necessity for realistic depreciation provisions, have led the board to obtain a revaluation of the company's fixed assets. This has been made as at April 1, 1956, on a " going-concern " basis, and shows an excess of approximately £1,100,000 over the March 31 written down, or balance-sheet, value of £1,534,715.

TRIPLEX FOUNDRY, LIMITED—No ordinary dividend is recommended for the year ended March 31, against 7½ per cent. for 1954-55. A group loss, after tax, of £9,762 was incurred (against the parent company's profit of £6,509). Credit is taken for surplus on the sale of land and buildings of £17,685 (nil). After writing £5,237 (nil) off the costs of acquisition of the subsidiary, the " carry forward " is virtually unchanged at £25,953 (£25,639).

NEGRETTI & ZAMBRA, LIMITED, scientific instrument manufacturers, of London, W.1—The directors state that trading results for the first six months of the current year show an advance on the previous year, and they feel justified in increasing the interim dividend on the £350,000 combined ordinary and "A" ordinary from 3 per cent. to 4 per cent. A final of 10 per cent. made a 13 per cent. total for the previous year to September 30, 1955.

WOLVERHAMPTON METAL COMPANY, LIMITED—Group operations in the year to March 31, 1956, benefited from factors which included continuation of a policy aiming at stability in trading. Turnover increased by over 40 per cent., largely due to the " phenomenal increase " in the price of copper. Output of finished material also showed a small tonnage increase. Arising from the subsequent fall in copper the board deemed it prudent to resume transactions on the London Metal Exchange further to protect the position, says the chairman, Mr. T. C. James.

W. H. ALLEN, SONS & COMPANY, LIMITED, engineers, of Bedford—At the annual meeting on July 18, Mr. W. Kenneth G. Allen, chairman, said the company's policy is first to secure the future by carrying out the modernization programme, together with a reasonable degree of expansion, and secondly, the maintenance of a prudent dividend policy to finance such measures in these days of high taxation. This will include provision of the necessary working capital for the purchase of additional services and materials consequent upon greater turnover and the building up of reserves.

MUREX, LIMITED—The ordinary distribution is maintained at 20 per cent. with a final payment of 12½ per cent., against a final dividend of 9 per cent. and a bonus of 5 per cent. In April, 1955, a tax-free distribution of 10 per cent. was made from capital profits. In spite of keen price competition, especially in ferro-alloys and in welding electrodes, the overall volume of sales increased. An overall improvement in activities at Rainham and Waltham Cross enabled the absorption of the major part of the rise in costs. The company's interests in those metals of importance to atomic energy, gas turbine, and jet aircraft developments continue to expand.

News in Brief

THE telephone number of Winston Electronics, Limited, Shepperton (Middx), is now Walton-on-Thames 6321.

BRITISH RAILWAYS has placed an order for machines for its Cowlairs Works, Glasgow, with Alfred Herbert, Limited, Coventry.

A REVISED total attendance figure of 102,316 for the International Machine Tool Exhibition at Olympia is reported by the Machine Tool Trades Association.

L. A. KNIGHT & E. G. KING LIMITED, 65 Victoria Street, Windsor, Berks, has removed its main die-casting works to 263, Argyll Avenue, Slough, Bucks (telephone: Slough 20247).

Stahl und Eisen, the leading German iron and steel journal, is this year celebrating the 75th anniversary of its first issue. To the Editor and his colleagues the JOURNAL offers its sincere congratulations.

ADDITIONS to its foundry department are to be carried out by the Distington Engineering Company, Limited, Workington, but a scheme for extending the engineering department has been dropped.

MORE THAN 900 EMPLOYEES of Herbert Morris, Limited, of Loughborough, travelled in 22 coaches to Cleethorpes, on the occasion of the firm's annual outing. The board of directors contributed to the cost of the trip.

Mr. G. T. WHITEHOUSE, chairman and joint managing director, Metal Products Company (Willenhall), Limited, said at the annual meeting in Wolverhampton recently, that at present the firm's export orders stand at a record total.

THE SUPPLY of a new type of pre-stressed concrete pipes for an 8½-mile aqueduct is covered in an order worth £231,000 which has been received by the Stanton Ironworks Company, Limited, Nottingham, from the River Dove Water Board.

FOUNDRIES with plans in hand for extensions to their premises include: M. W. Swinburne (Brassfounders), Limited, Wallsend; Newby & Sons (Ironfounders), Limited, West Bromwich, and G. W. B. Furnaces, Limited, Sedgley, Staffs.

LURIA BROTHERS & COMPANY, INC., announce that since they have acquired dock-side space in Los Angeles, the scrap exports of that city will be increased four-fold and be of the order 400,000 tons a year. At the moment it is of the order of 104,000 tons, 80 per cent. of which goes to Japan.

A NEW shipowning company is to be formed by Wm. Cory & Son, Limited, and B.I.S.C. (Ore), Limited, for the carriage of ore in bulk. An order has been placed with Blyth Dry Docks & Shipbuilding Company, Limited, for two bulk-ore carriers of 15,000 tons d.w. for delivery in 1959 and 1960.

PERMISSION has been granted by the Motherwell Dean of Guild Court for Colvilles, Limited, to build an extension to the No. 2 plate-mill despatch bay at its Dalzell Works, Motherwell, at a cost of £45,000, and for the erection of an elevated water tank at the Etna Works, Craigneuk, costing £25,000.

IN ADDITION to the contract recently awarded by the Shell Company of South Africa, Limited, for a large-scale "Lube" oil blending and packing plant at Durban, W. J. Fraser & Company, Limited, Romford (Essex), has now been commissioned to build and erect a complete grease manufacturing plant alongside.

METALLIC EXTRACTORS (NON-FERROUS), LIMITED, Marsh Lane, Water Orton, Birmingham, have submitted a calculator—based on revolving discs—which gives a very useful indication of the residue value of such waste as shop sweepings, foundry sand, and casters' ashes. It is available to readers on writing to Water Orton.

EIGHTEEN APPRENTICES employed by the Renishaw Iron Company, Limited, left on Sunday, July 22, under the leadership of Mr. W. S. McCollam, chief metallurgist, to visit Belgium. Through the courtesy of Mr. P. de Keyser, of Fabrimetal, arrangements have been made for the boys to visit a foundry in Ghent.

A THIRD British firm, Industrial Foundry Materials, Limited, Dudley Road, Lye, near Stourbridge, will be showing at the International Foundry Trades' Exhibition, in Dusseldorf, September 1 to 9. They are to occupy stand No. 419, Hall N., where the exhibits will include a range of "Steloy" shell-coreblowing machines.

WHAT IS BELIEVED to be the first 200-mw. turbo-generator to be installed in Canada, and the first to be exported from England, has been ordered from C. A. Parsons & Company, Limited, by the Hydro-Electric Power Commission of Ontario. An order for a similar generator in this country has been placed with the company by the Central Electricity Authority.

THE 24TH INTERNATIONAL FOUNDRY CONGRESS, to be held in 1957 in Stockholm, is being designed to cover the following subjects: ventilation of foundries; the mechanical testing of cast metals; modern sand-binders—especially CO_2 and shell-moulding processes; modern developments in cupola practice—basic-lined and hot-blast cupolas, and the casting of non-ferrous metals.

PANORAMA EQUIPMENT, LIMITED, 29/36, Seymour Mews, Wigmore Street, London, W.1, have been appointed sole UK agents for the German firm of Draeger-Werk, which manufactures a wide range of protective masks. One type—the "Draeger" semi-mask No. 74—allows of a choice of filters to be inserted to cater for differing atmospheric conditions.

DARLINGTON FORGE, LIMITED, has received an order for finish-machined marine shafting, comprising 850 tons of forgings to the value of over £150,000, for delivery to the Continent during the next three years. It was obtained in the face of strong competition. The present value of direct orders on the company's books for the export market is the highest recorded in its history.

THE EDUCATION COMMITTEE of Edinburgh Town Council has approved the building of a new technical college on the Merchiston Castle site in Edinburgh, with the preservation of the castle tower as an integral part of the scheme. The new college, to be named the Napier Technical College in memory of the inventor of logarithms, Napier of Merchiston, will cost about £1,000,000.

THE FIRST INSTALMENT of a major extension to Cardiff College of Technology and Commerce is to be included in the city's education authority building programme for 1957-58. The Ministry of Education is to include the project, estimated to cost £300,000, in that year's programme. The college is one of eight which are being designated by the Ministry as colleges of advanced technology.

Mr. T. C. JAMES, chairman of the Wolverhampton Metal Company, Limited, in his report, states that the company is bringing into production a large unit for treating complex copper/zinc residues which in the past have mainly gone abroad. Mr. James criticizes the "increasing efforts of some metal merchants" to export

vital copper bearings, scraps and residues, which, with British labour, could be converted to finished products.

BECAUSE IT HAS FOUND no evidence of any material alteration of circumstances since a bonus of 3d. gross per hour worked was awarded last November, the Industrial Court has found against a claim put forward by the National Union of General and Municipal Workers on behalf of 600 craftsmen's mates and 500 men in miscellaneous grades, who are employed by Steel, Peech & Tozer, a branch of the United Steel Companies, Limited, and the Park Gate Iron & Steel Company, Limited. The men sought an increase of 3d. an hour on the stabilized bonus payment they receive at present.

THE sixth Commonwealth Mining and Metallurgical Congress is to be held in Canada next year. It opens in Vancouver on September 8 and ends in Halifax, Nova Scotia, on October 9. The tour arranged is particularly comprehensive; one trip by air allows for visits as far north as Dawson City and includes Uranium City; a second, by rail, includes Edmonton. The two join up at Winnipeg and continue with other off-shoots to Montreal and Quebec. Details of this attractive congress are to be had by writing to the executive secretary, 507, Metropolitan Building, 837 W. Hastings Street, Vancouver 1., B.C., Canada.

THREE SUCCESSES were scored by Brook Motors, Limited, Huddersfield, in the annual competitions of the Sheffield and District Works and Private Fire Brigades Associations on July 14. Teams from the company won the Embassy, Samuel Fox, and Barker cups. Cravens, Limited, was successful in the Branson and Merryweather cup events, while William Jessop & Sons, Limited, completed a double in winning the "Sheffield Telegraph" and the Vice-president's cups. The Humphries Cup was won by Samuel Fox & Company, Limited; Hadfields, Limited, took the Burchy Cup, and the Gladwin Trophy went to Smith-Clayton Forge, Limited, Lincoln.

WITHIN A FEW HOURS of the announcement that the British Motor Corporation had declared redundant several thousand men at BMC plants in Birmingham and Oxford, Mr. W. E. Bullock, production director of Guy Motors, Limited, of Wolverhampton, had despatched a van and staff to the employment exchange at Selly Oak, Birmingham, to offer jobs to displaced men from the Austin works at Longbridge. The van made several journeys into Birmingham, and as a result of this recruiting campaign nearly 500 inquiries were dealt with on the spot. In consequence, approximately 70 men—the majority of them ex-Austin employees—have been given jobs at Guys. The firm emphasizes that the vacancies filled were due to a general shortage of labour which has existed since 1939, and not to any new expansion programme.

Dr. D. F. GALLOWAY, who is directing research in automation problems at the Production Engineering Research Association centre at Melton Mowbray, has returned from a visit to America and Canada where he gave a series of lectures to engineering organizations. He found that in many respects, research in Britain is ahead of that in the USA and Canada, where work is mainly undertaken by separate firms. In this country, in the Engineering Research Association, over 500 companies are pooling research facilities, a co-operation which means that benefits are more readily disseminated to all. America having accepted automation is concerned with facing the problems that stem from it, notably the need for more technicians. One of the automation feats Dr. Galloway saw, was a 300-ft. line producing assembled cylinder-heads at the rate of 400 an hour with a labour strength of three men.

Obituary

Mr. O. J. HEATHCOTE, formerly head wages clerk for 57 years at the Stanton Ironworks Company, Limited, near Nottingham, has died at the age of 87.

The death is reported of Mr. W. H. T. TURNER, who for many years was secretary of the Blackheath (Staffs) works of Firth-Vickers Stainless Steels, Limited.

Mr. HORACE JOHN CROFT, who 20 years ago founded George Croft, Limited, makers of bright-drawn steel bars and furnace builders, of Great Bridge, Tipton (Staffs), has died at the age of 66.

The death has occured of Mr. J. E. FOSTER the chairman of the West Midland Refining Company, Limited, Walsall. He had been associated with the company since its inception in 1919.

The death has occurred of Mr. NOEL D. RIDSDALE, founder and managing director of Ridsdale & Company, Limited, analytical, research, and metallurgical chemists, of Middlesbrough. He was a founder member and past-president of the Tees-side section of the Institute of Metallurgists and of the Royal Institute of Chemistry of Great Britain and Ireland. With his wide experience in methods of analysis, he served on a number of national committees, chiefly in relation to metals.

Increases in Capital

ALLCOCK & COMPANY (METALS), LIMITED, Birmingham, increased by £10,000, in £1 "A" ordinary shares, beyond the registered capital of £10,000.

CHARRINGTON, GARDNER, LOCKET & COMPANY, LIMITED, increased by £800,000, in 5s. ordinary shares, beyond the registered capital of £700,000.

BRITISH APPLIANCES MANUFACTURING COMPANY, LIMITED, Leeds, increased by £20,000, in £1 ordinary shares, beyond the registered capital of £20,000.

A.1 ELECTRIC WELDING MACHINES, LIMITED, London, S.W.1, increased by £15,000, in £1 ordinary shares, beyond the registered capital of £10,000.

WARRINGTON TUBE COMPANY, LIMITED, London, S.W.1, increased by £35,000, in £1 ordinary shares, beyond the registered capital of £15,000.

SCOTTISH TAR DISTILLERS, LIMITED, Camelon, Falkirk, increased by £150,000, in 10s. ordinary shares, beyond the registered capital of £600,000.

PULSOMETER ENGINEERING COMPANY, LIMITED, London, S.W.1, increased by £450,000, in 5s. ordinary shares, beyond the registered capital of £300,000.

NEWBURGH ENGINEERING COMPANY, LIMITED, Bradwell, near Sheffield, increased by £49,000, in £1 ordinary shares, beyond the registered capital of £1,000.

FERRY-DIAMOND ENGINEERING COMPANY, LIMITED, London, E.C.2, increased by £10,000, in £1 ordinary shares, beyond the registered capital of £10,000.

GLEGG & THOMSON, LIMITED, iron merchants, etc., of Aberdeen, increased by £10,000, in £1 ordinary shares, beyond the registered capital of £30,000.

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT COMPANY, LIMITED, London, S.W.1, increased by £190,000, in £1 shares, beyond the registered capital of £10,000.

W. E. BURNARD & SON, LIMITED, electrical engineers, etc., of Sheffield, increased by £25,000, in £1 ordinary shares, beyond the registered capital of £25,000.

STEVAN & STRUTHERS, LIMITED, steel and iron founders, etc., of Glasgow, increased by £30,000, in £1 ordinary shares, beyond the registered capital of £30,000.

EDMISTON, BROWN & COMPANY, LIMITED, mechanical engineers, etc., of Glasgow, increased by £20,000, in £1 ordinary shares, beyond the registered capital of £50,000.

Recent Wills

GILLAM, ROBERT, iron and steel merchant, of Bradford	£33,471
PRATT, H. E., chairman of the Standard Range & Foundry Company, Limited, Watford (Herts)	£91,545
HATFIELD, R. A., managing director of the Burton Constructional Engineering Company, Limited, Burton-on-Trent	£48,663
ROBERTSON, N. C., deputy managing director of E. K. Cole, Limited, electrical engineers, etc., of Southend-on-Sea	£29,635

Personal

Mr. CHAS. A. OTTO is now residing at Kirby Heathfield, Cross Lane, Newton, West Cheshire.

Mr. PETER BLACK, foreman in the export department of Henry Balfour & Company, Limited, gas and chemical engineers and ironfounders, of Leven (Fifeshire), received a presentation on his retirement.

In addition to his first duties as works manager, Simplex Electric Company, Limited, Oldbury, Mr. J. BERNSTEIN has been appointed manager, Enamelled Iron and Steel Products Company, Limited, Oldbury.

Mr. LOUIS RUDERMAN is retiring at the age of 65 as head of the Electrical Department of the Wolverhampton and Staffordshire Technical College. He has been on the staff for 31 years and at one time was in addition head of the Mechanical Engineering Department.

In order to devote the whole of his time to the duties of executive chairman of the English Electric Company, Limited, Sir GEORGE H. NELSON has relinquished the position of managing director of the company. The deputy managing director, Mr. H. G. NELSON, has taken over the managing directorship.

Mr. P. F. LEWEY, director and secretary of George Waller & Son, Limited, Phoenix Iron Works, Stroud, Glos, who retired at the end of June after 56 years' service with the firm, has been presented with a chiming grandmother clock. Mr. Lewey's successor as secretary to the company is Mr. B. E. HEWES.

The technical committee of the Association of Bronze and Brass Founders have nominated Mr. F. C. BAKER of J. Hobkirk, Sons and Company, Limited, to represent the Association on BSI/MEE/22 committee—"Foundry Equipment and Foundry Patterns," and Mr. E. AYRES to serve on IBF sub-committee TS 49.

United Steel Companies, Limited, announce that Mr. A. A. H. DOUGLAS is relinquishing his appointment as director and general manager of the Distington Engineering Company, Limited, at his own request, and that Mr. G. N. F. WINGATE, at present works manager (services) at Steel Peech & Tozer, will succeed him as from August 1.

Mr. J. E. HARTWELL, who has 40 years' service with Henry Pooley and Sons, Limited, makers of scales and weighing machines, is to be presented with a gold watch. The presentation ceremony is to be held at the Birmingham foundry, where Sir Percy H. Mills, chairman of the company, will present other employees with long-service awards.

SIR EDWARD APPLETON, principal and vice-chancellor of Edinburgh University, and MR. A. C. HARTLEY, who was concerned with the creation of the war-time pipeline under the ocean, were inducted as hon. members of the Institution of Mechanical Engineers at Edinburgh on July 4. Mr. Hartley is a past-president of the Institution.

Mr. H. W. G. HIGNETT has been appointed assistant managing director of Henry Wiggin & Company, Limited. Mr. Hignett, who is a director of the company, was responsible for technical (metallurgical) control and development in all the company's plants and was previously superintendent of the Mond Nickel Company's Birmingham research laboratory.

At a meeting of the Council of the Institute of Industrial Administration, the Bowie medal for 1956 was presented to Mr. E. F. L. BRECH, who is a consultant, author, and lecturer on management subjects. Mr. Brech is a senior partner in Urwick Orr & Partners, Limited, industrial consultants, of London, W.1, and is a member of the IIA council and a past-chairman of the London branch.

THOS. W. WARD, LIMITED, Albion Works, Savile Street, Sheffield, have appointed the following as directors: Mr. CLIFFORD PARRY, who was for many years the personal secretary of the late Joseph Ward; Mr. HERBERT H. MUMBY, who is connected with the shipbreaking business and non-ferrous section of the firm; and Mr. WILLIAM HALL, who is in the scrap-iron and steel department. They have all spent their business lives with the firm and became local directors in 1948.

Mr. J. STEELE, the new secretary of the South Africa branch of the Institute of British Foundrymen (and this year's recipient of the Oliver Stubbs' Medal of the Institute), has been awarded a non-member's diploma by the Institution of Production Engineers (S.A.) branch for his paper on "Thermit Casting" presented jointly to that body and the foundrymen. As Mr. Steele had already been awarded a diploma of the Institute of British Foundrymen for this paper, the new award makes a very creditable "double."

Mr. O. W. HUMPHREYS, the director of the General Electric Company, Limited, in charge of research, was elected president at Monday's annual meeting of the Institute of Physics. Dr. B. P. DUDDING was elected a vice-president, Dr. J. TAYLOR honorary treasurer, and Prof. F. A. VICK honorary secretary. The two new ordinary members of the board elected were Dr. L. R. G. TRELOAR and Mr. G. W. WARREN. Sir GEORGE PAGET THOMSON was elected to Honorary Fellowship in recognition of his contributions to physics and his services to physicists.

Board Changes

STEWARTS AND LLOYDS, LIMITED—Mr. S. W. Kaye has been elected a director.

BORAX CONSOLIDATED, LIMITED—Mr. N. C. Pearson has been appointed assistant managing director.

BORAX (HOLDINGS), LIMITED—Mr. T. H. Brand and Mr. J. N. Hogg have been appointed to the board.

WESTINGHOUSE BRAKE & SIGNAL COMPANY, LIMITED—Mr. Kenneth Pickthorn, MP, has been elected a director.

KENWOOD MANUFACTURING COMPANY, LIMITED—Mr. J. H. Senior has been appointed chairman of the company.

SWAN, HUNTER, & WIGHAM RICHARDSON, LIMITED—Mr. George Bennet Halley has been appointed a director of the company.

FORD MOTOR COMPANY, LIMITED—Mr. H. A. Denne and Mr. F. E. W. Hammond have been appointed executive directors.

SUNDERLAND SHIPBUILDING, DRY DOCKS & ENGINEERING COMPANY, LIMITED—Mr. A. L. Marr and Mr. J. V. Thompson have been appointed directors of the company.

MASSEY-HARRIS-FERGUSON, LIMITED — Col. Eric Phillips has been appointed chairman and chief executive officer of the company. He succeeds Mr. James Duncan, who for reasons of health has resigned as chairman, president, and director.

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REGD. TRADE MARK

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Prosperity and Human Freedom

Opening his study conference on the human problems of industrial communities at Oxford last month, the Duke of Edinburgh said it was very easy to get into the habit of thinking of industry as an end in itself. It was, of course, only a means to an end.

"The community, in fact, is more important than industry," he said. "It may not be very easy to decide what we are aiming at in this modern world of ours, but whatever the target we must take into account that all people are primarily citizens and not just workers with a bit of private life. I see no advantage in a prosperous, powerful State if it is to be achieved at the expense of human freedom and happiness."

Workers and Their Prospects

In a paper published as background to the conference Prof. D. W. Harding, Professor of Psychology at Bedford College, London University, said that more and more people were shedding, long before middle age, the notion of "getting on" as a directing principle of their working lives. He continued: "More and more workers are concerned less with prospects than with the nature of their job, their physical and social environment at work, the adequacy of their immediate reward in wages and free time, and the state in which the job leaves them in the evening and at the week-end. Industry must settle down to using a larger proportion of people who are not allured by the prospects of advancement and will not accept their work as the central preoccupation of their lives. They can still be perfectly loyal workers, taking pride in what they do, and giving a fair return for their wages."

In another paper, Sir Hugh Casson, Professor of Interior Design at the Royal College of Art, said: "An ill-lit workshop, a grubby canteen, an unkempt factory approach can in a week destroy a year of carefully constructed good relations between management and worker and build up an atmosphere—often unconscious—of resentment and 'couldn't care less' which will lead eventually to trouble. Conversely, a bucket of whitewash liberally applied in the right places does far more good for morale than a pep-talk from the works manager."

The Duke of Edinburgh was in the chair on the second day when Sir John Maud, Permanent Secretary to the Ministry of Fuel and Power, addressed the conference on "The Impact of Industrialization." Sir John said that the first fact about industrialization was that it enormously increased our power, and therefore our responsibility for what happened in the world. The second fact was a constant shifting in the balance of power. New men and organizations ran the show—in the industrial field large employers, trade unions, and the boards of nationalized industries; in the field of government new political parties and new types of political leader. The third fact was a negative one—that there was nothing inevitable about the results of industrialization. Whether the consequences were for better or worse depended entirely, in Sir John Maud's belief, on the success or failure with which the new powers were used, and particularly on the people chiefly responsible for using them.

Industrialization was, in short, a fearful menace and a tremendous opportunity. It threatened to destroy us—to standardize us, dividing our life into compartments of "work" and "leisure," to destroy our personal relationship to each other and substitute that of cogs in a machine. At the same time industrialization offered us fullness of life in a sense never within our grasp before—enough food for the two thirds of the world's people now underfed, freedom from much drudgery, time to exercise our creative capacities.

What did this challenge demand of us? Chiefly, he suggested, imagination and character. "The factory was made for man, not man for the factory"—it was easy to say that, but difficult to make sure it was true in practice. He was convinced that we retained our master of the machine and avoided becoming its servant only by "serving something else."

What we had to do if we were seriously going in for this adventure of industrialization—and Sir John Maud made it plain that we had really no option in the matter—was to keep firm hold of what we believed—about the fundamental difference between good and bad, truth and falsity, beauty and ugliness—and try to built our new industrial society on the rock of those beliefs. He suggested that one of the foundations should be that principle of trusteeship which he found in the history of the Commonwealth. The other important thing was faith in the supreme value of individual people.

Varying Pattern of Industry

Another speaker was Lord Citrine, chairman of the Central Electricity Authority, who took "The Varying Pattern of Industry" as his subject. He said that the operators of most of the large-scale units known today as combines and more usually referred to as trusts in earlier decades were formerly thought to be contrary to the public interest. He added: "Personally, I am not afraid of the trust."

Lord Citrine said he believed that the pursuit of private profit in modern industry by large-scale undertakings could not go on unaccompanied by social obligations. Those undertakings were, moreover, easier to control. Creation of large industrial combines brought about a higher technique, both of directorship and of management, and the responsibility falling on those at the head of such units tended towards the creation of a better type of industrial leader. Such men, presiding over firms with a capital of many millions, and thousands of employees, and making far-reaching decisions every day, were likely to possess a broader outlook than those who presided over the destinies of small businesses.

Dorman Long's Increased Costs

Results at the iron and steel works are being adversely affected in the current half-year by increases in wages and transport charges and in coal and fuel oil prices, as well as the embargo on overtime by craftsmen on maintenance work.

This statement was made by the directors of Dorman Long & Company, Limited, when they announced that they had decided to pay an interim dividend for the year to September 30 of 3 per cent., less tax, on the £15,000,000 ordinary capital payable on August 15 to holders registered on July 16. The board states that in its view the profits for the half-year to March 31 justify the payment of this dividend.

Transformers. Amongst a collection of catalogues and price lists received from Foster Transformers Limited, South Wimbledon, London, S.E.19, is list 1305/7 which covers the selling prices of transformers for portable tools and lighting. Voltage control in this sphere is becoming of increasing importance to the foundry industry.

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Raw Material Markets

Iron and Steel

Good outputs of pig-iron continue to be maintained from the furnaces in blast. Deliveries of ore from both home and oversea sources are sufficient to cover consumption and to provide some stock. The reduced consignments of ore from North Africa have deprived mainly the makers of hematite and low-phosphorus iron of supplies. Some difficulty still exists in obtaining adequate tonnages of the higher-grade ores in the desired analyses, the shortage of which is restricting the makers of these grades of pig-iron in providing the foundries with their requirements, particularly in the higher silicon ranges. Supplies of blast-furnace coke are forthcoming in fairly good quantities, but with the blowing in of additional furnaces later in the year, much larger tonnages will be required from the ovens.

More than 75 per cent. of the pig-iron output finds its way to the steelworks. Some steelmakers are still short of supplies and have to rely on imports, but the new furnaces which will be brought in later in the year will relieve the position. Demands from the foundry trades for pig-iron have eased considerably. Low-phosphorus iron and hematite, for which there was a heavy call up to a short time ago, are now of less interest, due mainly to the recession in the motor-car industry. Larger tonnages have thus been released for other engineering and speciality foundries, which are busily engaged in the production of high-duty castings. Outputs of high-phosphorus pig-iron are about sufficient to satisfy current demands. There is, however, little margin. Many of the light foundries are short of work. The jobbing foundries are fairly busy, but the textile foundries could do with more orders.

Deliveries of steel semis to the re-rollers have not yet been interfered with seriously on account of the maintenance men's dispute, but a continuance or an extension of the dispute would jeopardize supplies. There is also the possible interference in deliveries from abroad on account of the strike in the American steel industry. The re-rollers are busy and have good order-books; any hold-up in supplies of steel would be serious. They have sufficient work on hand to obtain maximum outputs, but many are prevented from doing so because of shortage of manpower, although the position has shown an improvement to some extent.

Non-ferrous Metals

Markets are featureless on both sides of the Atlantic and in view of the United States steel strike, the advent of the holiday season, and the motor industry unrest in the United Kingdom, caution is the keynote. The undertone in copper in London, however, is reasonably steady. In the US the market is listless. Producers have opened their books for August, but business transacted is slight, as it seems that fabricators have yet to make up their minds about the permanency of the producers' price of 40 cents a pound for copper. At present activity is concentrated on the cheaper Custom smelter copper and on dealers, who are offering foreign copper at 36¼ cents to 37 cents a pound.

Tin is weakening in face of the steel strike, although the situation in the East is far from healthy. Thus movements in this market remain limited. It is thought, however, that the market for tinplate should become strong with the cessation of the steel strike, as stocks are being steadily consumed. Consumers are not, however, in any immediate trouble as many normal inventories will support operations for six to seven weeks.

Lead is a dull market both here and in America, but the news over the weekend that the US Government had acquired about 35,000 tons of lead through barter deals is a steadying influence. Zinc is also quiet and the price is easing to lower levels. The US Government is believed to have acquired around 15,000 tons of zinc this month for the stockpile, in addition, of course, to the 100,000 tons of foreign zinc acquired under barter deals, an operation which has helped to keep the European price steady. However, the US Government is now temporarily out of the market for foreign zinc, although not for lead.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* July 19, £284 to £285; July 20, £284 10s. to £285; July 23, £284 10s. to £285; July 24, £281 10s. to £282; July 25, £283 to £283 10s.

Three Months: July 19, £283 to £284; July 20, £284 to £284 10s.; July 23, £283 10s. to £284; July 24, £280 10s. to £281; July 25, £282 10s. to £283.

TIN, Standard—*Cash:* July 19, £743 to £745; July 20, £748 to £750; July 23, £745 to £747; July 24, £742 to £743; July 25, £756 to £758.

Three Months: July 19, £742 to £743; July 20, £747 to £748; July 23, £744 to £745; July 24, £740 to £741; July 25, £754 to £755.

LEAD—*Second half July:* July 19, £113 10s. to £114; July 20, £113 10s. to £114; July 23, £113 15s. to £114; July 24, £113 to £113 5s.; July 25, £112 15s. to £113.

Second half October: July 19, £112 5s. to £112 10s.; July 20, £112 10s. to £112 15s.; July 23, £112 10s. to £112 15s.; July 24, £111 15s. to £112; July 25, £111 10s. to £112.

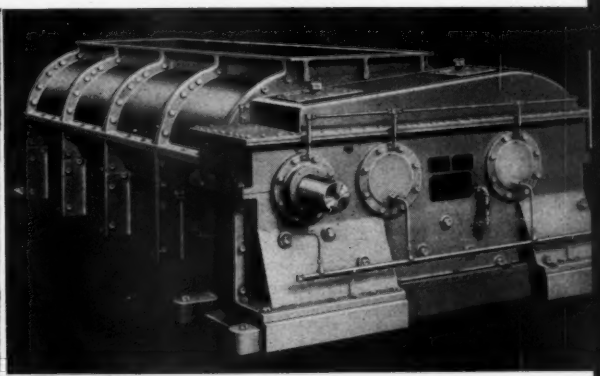
ZINC—*Second half July:* July 19, £93 10s. to £93 15s.; July 20, £93 10s. to £93 15s.; July 23, £93 5s. to £93 15s.; July 24, £92 15s. to £93; July 25, £93 to £93 5s.

Second half October: July 19, £92 10s. to £92 15s.; July 20, £92 10s. to £92 15s.; July 23, £92 5s. to £92 10s.; July 24, £91 15s. to £92; July 25, £92 5s. to £92 10s.

Removal of Phosphorus from Molten Pig-iron by Top Blowing

A series of experiments has been carried out on the top blowing of molten pig-iron with oxygen for the removal of phosphorus and is briefly referred to in the BISRA (Chemistry Section) annual report for 1955. Batches of metal weighing 25 lb. and 2½ lb. of pre-fused slag were used. The original pig-iron contained 3.3 per cent. carbon, 2.0 per cent. phosphorus 0.7 per cent. silcon, 1.4 per cent, manganese and 0.1 per cent. sulphur. During each blow, several slag and metal samples were taken and temperatures measured. The results indicate that the oxidation of phosphorus is a first-order reaction and that the specific rate constant increases with the basicity of the initial slag-forming materials; fluorspar added to the initial slag appreciably increased the rate of removal of phosphorus. After blowing for about 25 min. the phosphorus content could be reduced to 0.1 or 0.2 per cent., while the carbon content remained at 2.5 per cent. or more. Silicon was removed almost completely within the first five to ten min. During the early stage of blowing, the metal is supersaturated with oxygen, but when the carbon boil starts, the supersaturation falls rapidly. This method of removing phosphorus, while leaving substantial carbon, appears to have promise for pre-refining before charging iron into the open-hearth furnace and for improving the quality of iron for foundry uses. Large-scale trials are being arranged.

Batch and Continuous Sand Mixers



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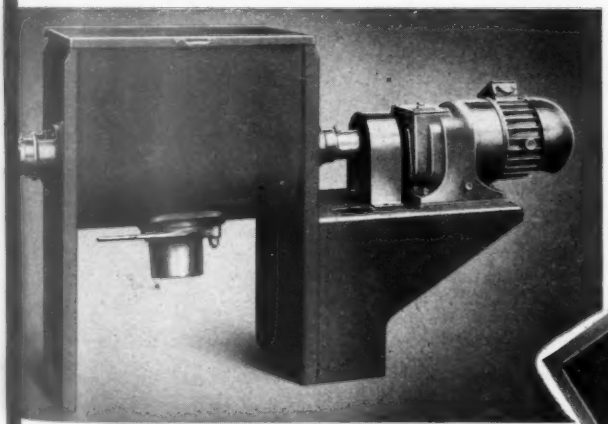

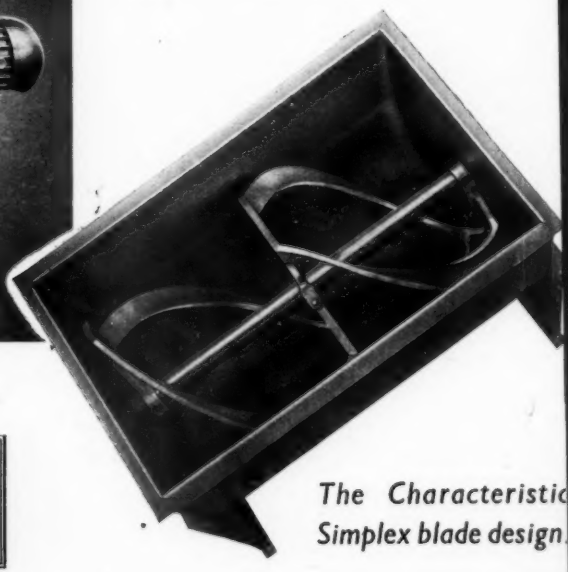

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

July 25, 1956

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £17 11s. 0d.; Birmingham, £17 3s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £20 8s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £20 12s. 3d.

Scotch Iron.—No. 3 foundry, £21 14s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £23 16s. 6d.; South Zone, £23 19s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 4s. 0d.; South Zone, £25 6s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent. :—N.-E. of England (local iron), £21 7s. 6d.; Scotland (Scotch iron), Zone S. 1, £21 14s. 0d.; Sheffield, £22 14s. 6d.; Birmingham, £23 2s. 0d.; Wales (Welsh iron), £21 7s. 6d.

Basic Pig-iron.—£18 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £48 0s. 0d. to £50 5s. 0d., scale 16s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £73 2s. 6d., scale 16s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 27s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 17s. 4d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 4d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent.C, £93 10s.0d. to £95 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; over 6 per cent. C, £92 10s. 0d. to £93 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; 2 per cent. C,* 2s. 1d. per lb. Cr; 1 per cent. C,* 2s. 1½d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 6d. to 23s. 6d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £66 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £28 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £29 19s. 0d.; hard (0.41 to 0.60 per cent. C), £31 0s. 6d.; silico-manganese, £39 10s. 0d.; free-cutting, £33 3s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £36 14s. 6d., silico-manganese, £39 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £34 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £35 16s. 0d.; acid, up to 0.25 per cent. C, £38 17s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £35 7s. 0d.; boiler plates (N.-E. Coast), £37 17s. 0d.; floor plates (N.-E. Coast), £36 16s. 0d.; sectional material, N.-E. Coast, £33 16s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots), £36 3s. 0d.; flats, 5 in. wide and under (4-ton lots), £36 3s. 0d.; hoop and strip, £36 12s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £38 16s. 0d.; black sheets (hand mill), 17/20 g., £50 4s. 6d.; galvanized corrugated sheets, 24 g., £62 7s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £61 13s. 9d.; nickel-chrome, £85 10s. 6d.; nickel-chrome-molybdenum, £96 16s. 6d.

NON-FERROUS METALS

Copper.—Cash, £283 0s. 0d. to £283 10s. 0d.; three months, £282 10s. 0d. to £283 0s. 0d.; settlement, £283 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 8¾d. per lb.; rods, 319s. 3d. per cwt. basis; 20 s.w.g., 352s. 6d. per cwt.

Tin.—Cash, £756 0s. 0d. to £758 0s. 0d.; three months, £754 0s. 0d. to £755 0s. 0d.; settlement, £758 0s. 0d.

Lead (Refined Pig).—Second half July, £112 15s. 0d. to £113 0s. 0d.; second half October, £111 10s. 0d. to £112 0s. 0d.

Zinc.—Second half July, £93 0s. 0d. to £93 5s. 0d.; second half October, £92 5s. 0d. to £92 10s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £125 0s. 0d.; rolled zinc (boiler plates), all English destinations, £122 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 3d. per lb.; rods, drawn, 3s. 1¾d.; sheets to 10 w.g., 306s. 0d. per cwt.; wire, 2s. 10¾d.; rolled metal, 291s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £184; B6 (85/15), — ; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), — HTB2 (38 tons), — ; HTB3 (48 tons), — .

Gunmetal.—BS1400, LG2 (85/5/5/5), £251; LG3 (86/7/5/2), £260; G1 (88/10/2/[1]), — ; (88/10/2/1), — .

Phosphor Bronze.—BS1400, PB1 (AID released), — per ton.

Phosphor Bronze Strip, etc.—Strip, 419s. 9d. per cwt.; sheets to 10 w.g., 444s. 3d. per cwt.; wire, 4s. 4½d. per lb.; rods, 3s. 8½d.; tubes, 3s. 6¾d.; chill cast bars: solids 3s. 8d., cored 3s. 9d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11¾d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4¼d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £84 10s. 0d. to £84 15s. 0d. Nickel, £519 0s. 0d. Aluminium ingots, £189 0s. 0d.; aluminium bronze (BS1400), AB1, — ; AB2, £292. Solder, brazing, BS1945, type 8 (50/50), 3s. 1d. per lb., type 9 (54/46), 3s. 4¼d. per lb.

* Average 68–70 per cent.